The Engineer

LONDON, FRIDAY, NOVEMBER 20, 1942.

PUBLIC NOTICES

LOUGHBOROUGH COLLEGE

Principal: Dr. H. SCHOFIELD, M.B.E.

Applications are Invited for the POST of LECTURER in the MECHANICAL and CIVIL ENGINEERING DEPARTMENT. This appointment is for FULL-TIME DAY COURSES to the standard of Honours B.Sc. Eng. Degree.

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
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THE PROPRIETOR of BRITISH PATENT No. 512,749, dated February 25th, 1939, relating to "Tractor Hitch," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN and CARLBERG, Steger Building, Chicago, Illinois. 8990 H

THE PROPRIETORS of BRITISH PATENTS Nos. 292,494, 351,079, 353,525, 354,707, 383,531, 383,532, 406,510, 414,211, 474,275, 465,745, 472,018, 442,211, 445,901, 445,910, and 489,578 are PREPARED to LICENSE BRITISH MANUFACTURERS to WORK THEREUNDER. They relate to Rolling Mills and Methods and Apparatus for the Rolling and Coiling of Metal Strips, Bands, and Sheets.—Address, BOULT, WADE and TENNANT, 112, Hatton Garden, London, E.C.1. 9014 H

THE PROPRIETORS of PATENT No. 463,115, for "Improvements in or relating to a Method of and Machine for Treating a Steel Rope," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. 9003 H

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MISCELLANEOUS

BOUND VOLUMES or COPIES of "THE ENGINEER," January to June, 1932, and January to June, 1937, WANTED.—Address, F. M. P. (or telephone Central 6565), The Engineer Office. 8873 I

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A Seven-Day Journal

F.B.I. and Post-War Problems

In order to deal effectively with post-war problems, the Federation of British Industries has set up three committees. They are :—The Organisation of Industry Committee, under the chairmanship of Sir Charles Bruce-Gardner, to seek evidence from 180 trade associations representing organised industry; the Transport Reconstruction Committee, under the chairmanship of Mr. J. J. Hughes, to consider the needs of industry in relation to all forms of transport after the war; and a committee has also been formed to discuss with United States organised industry their reactions, which are expected shortly, to the F.B.I. report on reconstruction. Last week, at a meeting of the F.B.I. Executive Committee, the importance of scientific research into the future of British industry was stressed, and it was decided to appoint a committee to consider and report on that subject. It is pointed out that, although many firms possess first-class research organisations and although there are twenty-one industrial research associations formed on a national basis, further steps are needed to impress on industry as a whole the need for research and to encourage all industries to reach the high standards already achieved by some. Whilst industrial research is carried out either by the individual firm or by the individual industry acting through some form of research organisation, it is felt that the F.B.I., in consultation with such bodies as the Department of Scientific and Industrial Research, might play a most useful *rôle* by surveying the existing research activities of industry and working in this matter in close co-operation with the Government, by publicising the importance of research and the practical benefits to be derived from it, by helping industries or firms which have not previously undertaken research work to make contact either with suitable institutions or with other firms whose experience might be valuable to them in forming their plans, and by studying the question of the education of research workers and their recruitment into industry.

Shipbuilding Employers' Federation

On Friday last, November 13th, the annual general meeting of the Central Board of the Shipbuilding Employers' Federation was held at Carlisle. Mr. Louis V. Dunlop, the general manager of Harland and Wolff, Ltd., of Govan, was elected President for the coming year, in succession to Mr. H. B. Robin Rowell, of R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne. Mr. F. E. S. Beavan, the general manager of the Mountstuart Dry Docks, Ltd., of Cardiff, who was already a Vice-President, was elected Senior Vice-President. Mr. J. Ramsay Gebbie, the managing director of William Doxford and Sons, Ltd., of Pallion Shipyard, Sunderland, and Mr. T. Morison, a director of Swan, Hunter and Wigham Richardson, Ltd., of Wallsend Shipyard, Wallsend-on-Tyne, were elected Vice-Presidents. Mr. F. W. Knight, director and works manager of Mills and Knight, Ltd., dry-dock owners and ship repairers, of London, was elected Chairman of the Conference and Works Board, with Mr. C. W. Moss, the shipyard manager of Vickers-Armstrongs, Ltd., of Barrow-in-Furness, as Vice-Chairman.

Employment Returns

The Employment Returns, which were issued by the Ministry of Labour and National Service on Thursday of last week, November 12th, state that the number of men and boys registered at employment exchanges in Great Britain as wholly unemployed at October 12th, 1942 (exclusive of 22,883 men who had been classified by interviewing panels as unsuitable for ordinary industrial employment), was 60,769. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 1357; and those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 2746. As compared with September 14th, the numbers wholly unemployed showed a decrease of 2934, those temporarily suspended from work showed a decrease of 175, but unemployed casual workers showed an increase of 149. The corresponding figures for women and girls at October 12th, 1942, were 35,248 wholly unemployed (exclusive of those, numbering 990, who had been classified by interviewing panels as unsuitable for normal full-time employment), 839 temporarily stopped, and 121 unemployed casual workers. Of the 35,248 wholly unemployed, 1013 had been classified as unable for good cause to transfer to another area. As compared with September 14th, the numbers wholly unemployed showed an increase of 289, those temporarily stopped showed a decrease of 338, and unemployed casual workers showed a decrease of 19. Unemployment during the period under review fell in all the administrative divisions with the exception of the South Wales district, in which there was a slight increase.

Spreading Building and Civil Engineering Contracts

The policy of the Ministry of Works and Planning to spread the available work among as many suitable firms as possible has been extended during recent months. The measures adopted include restrictions on the total load that individual contractors may carry, provision for compulsory sub-contracting, grouping of firms to enable the smaller firms to undertake Government contracts, and consultation in the preparation of tender lists. These measures have been worked out with the national organisations in the industry. Among the special arrangements to prevent the overloading of individual contractors are the following :—A Central Register is kept of all firms who employed at July, 1941, 100 men or more (in Scotland, 75 men or more), and contractors on this list are invited to tender for contracts over £25,000. When their work in hand reaches 60 per cent. of the value of their average annual turnover in the years 1939–41, they are automatically excluded from the Government's invitation to tender list until their uncompleted work in hand falls to 40 per cent. of their so defined average annual turnover. At the end of October, out of the Central Register of about 1000 contractors, with an average turnover of more than £60,000 per annum, 105 contractors were on the "starred" list, as being ineligible to tender for building or civil engineering contracts. Five firms excluded in previous months had been readmitted during the month. Since these new arrangements were first considered in June last, nearly three-quarters of the firms on the Central Register have already been invited to tender for Government work. In addition, regional registers of all other firms are similarly maintained in order to deal with contracts costing £25,000 and under.

Economy of Mining Timber and Steel

The Minister of Fuel and Power has issued a Coal Mining Undertakings Control Order, 1942, General Direction (Supports Economy), No. 1, copies of which will be available shortly. It is pointed out that the utmost economy in the use of timber and steel used as support materials in collieries is essential, and the Order is designed to promote such economy. Its provisions take effect on December 1st. All colliery undertakings, other than those employing not more than thirty persons below ground, are called upon to employ supports economy officers, whose duties will be to ensure that supports are not wasted or uneconomically used, and to organise the systematic and thorough salvage of wood and steel. One officer is to devote the whole of his time to such work at every mine at which more than 500 persons are employed below ground. The Order also applies to every undertaking at which more than 1000 persons are employed below ground, even though the total number of underground workers at any mine within the undertaking does not exceed 500 persons. In order to reserve for use as props the sizes of round timber, which are in shortest supply, the use of round timber of 6in. diameter or less, or splits from such timber, as bars at the working face is prohibited. Round timber of 3in. diameter or more must not be used as covering for supports or in building packs or chocks. Regional Fuel and Power Controllers are empowered to exempt undertakings in special circumstances from compliance with any part of the Order.

Shipyard Welding and Lloyd's Register

The interest taken by the Committee of Lloyd's Register of Shipping in the development of electric welding for ship construction dates from the beginning of that industry, and has always been essentially practical. The technical staff of the Society has had special opportunities of watching welding procedure in every country engaged on the work. This is especially true of the United States, where the larger merchant shipbuilding programme undertaken by the British Government was wholly under the supervision of the surveyors to Lloyd's Register. As is well known, these ships are mainly welded and built by typical American methods. Therefore the surveyors engaged on this work can claim to possess a unique and first-hand knowledge of the subject of welding as applied to practical ship construction. With the increased interest in welding in this country, it became apparent that some of those members of the Society's American staff who had supervised a large number of welded ships from commencement to completion could be most usefully transferred to the United Kingdom, where their practical and technical experience would be helpful to shipbuilders and in the national interest. The Committee has therefore brought from America Mr. R. B. Shepheard, B.Sc., who has been lent to the Merchant Shipbuilding Department of the Admiralty as Superintendent of Welded Development (Merchant Shipping), and Mr. F. C. Cocks, B.Sc., who has been appointed Special Surveyor for Welding on the Chief Ship Surveyor's staff, where his services will be available to the staff of the Society and to the Society's clients in the United Kingdom.

Sir Roy Fedden's New Appointment

In the House of Lords on Tuesday, November 17th, Lord Brabazon, who was supported by Lord Sempill, raised the question of the recent dismissal of Sir Roy Fedden from the post of chief engineer of the Bristol Aeroplane Company, and asked for further information. Replying for the Government, Lord Sherwood, the Joint Parliamentary Secretary to the Air Ministry, referred to Colonel Llewellin's negotiations with Sir Roy and the Bristol Aeroplane Company since he succeeded Lord Brabazon as Minister of Aircraft Production, and his recent announcement that he had come to the conclusion that the war effort would best be served if the connection between Sir Roy Fedden and the company was brought to an end. It was recognised that Sir Roy Fedden's services were very great, and the Minister of Aircraft Production had offered him a position in which he would go to America in connection with matters of real importance relating to aircraft engines and various things implied. Sir Roy had accepted the Minister's offer. There would, of course, Lord Sherwood continued, be negotiations on the offer, but he was convinced that the job was of the highest nature, and much bigger than many things which could have been accomplished by Sir Roy Fedden remaining in the position he formerly occupied. Lord Brabazon said he thought that Sir Roy Fedden's chief work, in which he could be best employed, was with his own creation. It proved the excellency of the present Minister that he had arranged to use the services of Sir Roy Fedden in the best way he possibly could.

Plastics and the Engineer

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. C.E.

RECENT developments in the application of plastics have given the engineer a wide range of materials from which to choose for any particular duty. For example, Dr. Yarsley recently described a new patent by the British Thomson-Houston Company, which refers to new condensation products of silicon, oxygen, and at least one methyl group. These subsidiary groups are not attached to carbon as in all organic compounds, but to silicon, the main constituent of such substances as clay, mica, and asbestos.

All these new plastics are reported to have excellent dielectric properties. They can withstand a temperature of 200 deg. Cent. for days without discoloration, melting, or similar change, apart from embrittlement; *in vacuo* they retain their shape at 550 deg. Cent. Certain of these silicones, as they are called, can be used to bond mica, and would thus be valuable for producing laminated mica products now used throughout the electrical industry.

The above is only one of many recent advances in the technique of plastics, and it has been mentioned to show that progress continues without ceasing. By the end of this war we shall have a still wider range of materials of all kinds as a result of stimulated wartime development. In view of this, it may be interesting and useful to consider some aspects of the plant used for producing these materials and to emphasise some of the qualities needed to maintain high-speed quantity production.

For example, one of the most important factors to be considered is the best type of alloy steel to be used for the moulds. With non-corrosive plastics, such as bakelite, moulds can be made of several classes of steel; Nitralloy has given excellent results in bakelite moulds of simple design, where the finished mould allows for a radius on the edges and at the corners. It is important to note that Nitralloy can be hardened without distortion, an extremely high degree of hardness being obtained. Where sharp edges or corners are required, however, Nitralloy is not suitable; moulds of this type are used to produce several different parts which interlock to form an assembly. The nitriding process imparts a hardness of such intensity to the metal that a certain amount of brittleness is thereby unavoidable.

In the moulding of synthetic resins of the thiourea and vinyl groups, corrosive action between these substances and the mould has to be resisted. Stainless steel with a high chromium content is attacked, but it has been found in practice that 16/2 nickel-chrome steel of the Firth-Vickers S.80 type can be used with much success. Although satisfactory from a corrosion-resisting point of view, this steel can be hardened to a maximum Brinell number of between 350 and 360. Chromium-plated moulds are suitable for the manufacture of synthetic resins, and experiments have indicated that Nitralloy is unaffected by these substances at temperatures in the region of 150 deg. Cent. which is the probable working temperature.

Where conditions are hard and where long life is required, Firth-Brown Diehard high-chromium steel is often used. By tempering at between 200 deg. and 210 deg. Cent., the hardest condition is obtained, greater toughness being ensured by tempering at from 400 deg. to 450 deg. Cent. A special low-expansion alloy, known as Nonva, containing about 36 per cent. of nickel, is used for moulds of intricate design.

For moulding bakelite and similar substances for general purposes, case-hardening steels are widely employed. Oil and air-hardening nickel-chrome steels are also used, and even mild steel is found to be suitable. Where the mould may be used repeatedly after long intervals, it is important to employ rust-resisting steel; high-chromium steels are therefore used for such moulds. Firth-Vickers F G and F H types are very suitable for this purpose.

High production rate depends very largely upon efficient and well-designed hydraulic presses, a good example of which is shown in Fig. 1. This press, made by T. H. and J. Daniels, Ltd., of Stroud, has a capacity of 200 tons, and combines the twin attributes of high-speed production and ease of operation. Controlled by a single-lever piston valve, the press closes when the lever is pulled and opens when it is pushed. When the lever is pulled pump pressure is applied to the main ram through an unloading valve, and the jack rams are then opened to the sump, whilst the prefiller valve will be opened to the overhead tank. This allows the main ram to fall by gravity.

As soon as the platens have met, pressure is applied by the low-pressure side of the pump up to a maximum of 500 lb. per square inch. At that point an unloader valve takes the load off the pump, and pressure is then built up by the high-pressure pump until it reaches a maximum value of 2000 lb. per square inch. This high pressure is released

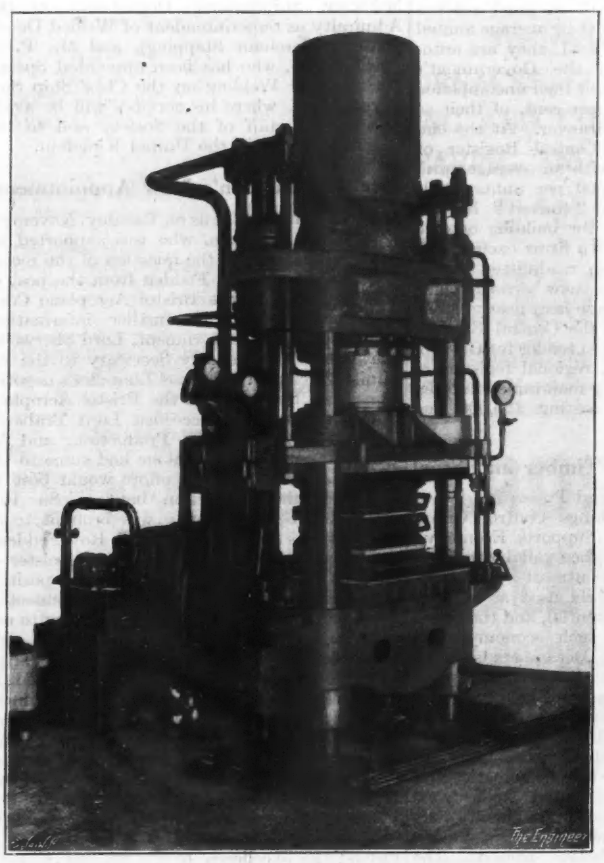

FIG. 1—HYDRAULIC PRESS

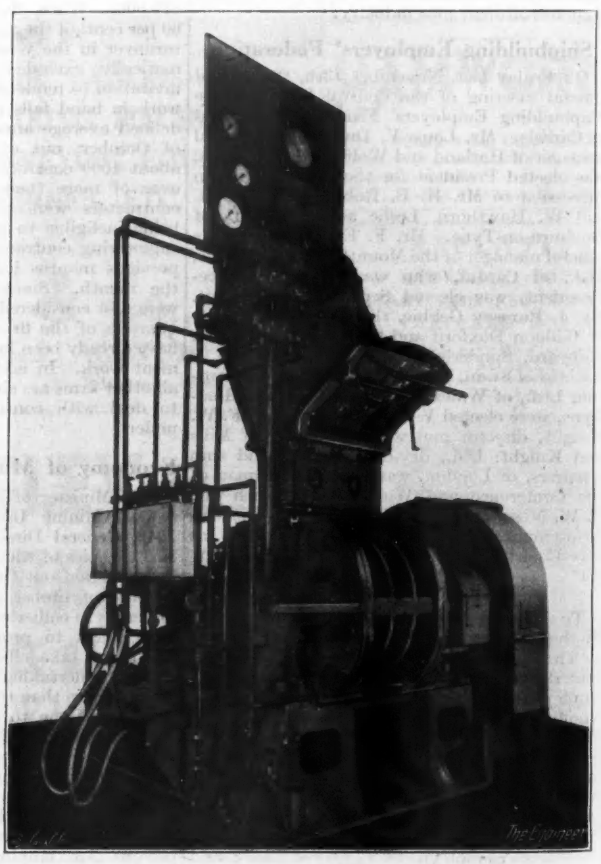

FIG. 2—MIXING MACHINE

through the unloader valve. In the meantime, pressure is maintained on the rams, and should this pressure drop through the squeezing up of the material between the platens, the unloader valve once again brings the high-pressure pump into action automatically.

On completion of the pressing operation

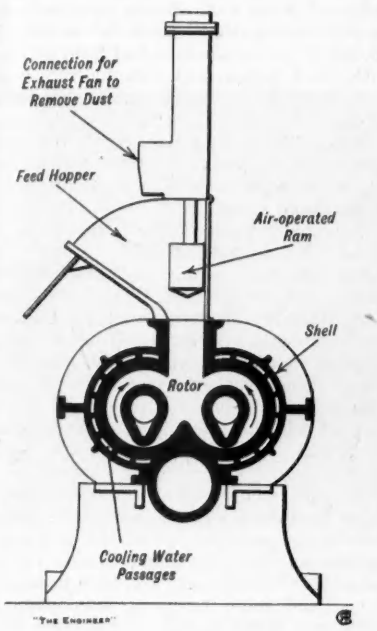

FIG. 3—CROSS SECTION OF MIXER

the main valve lever is pushed, and this releases the pressure from the main cylinder and applies it to the jack rams. Oil from the main cylinder returns through the prefiller valve to the tank on the pressure head, surplus flowing down through the pipes into the main supply tanks. This single-lever operation makes for simplicity, the oil-hydraulic pressure system being free from maintenance troubles.

The Vickers high and low pressure pumping plant is operated by an electric motor, on one side of which is mounted a low-pressure constant-delivery pump of the vane type. It delivers 5 gallons of oil per minute at a pressure of 500 lb. per square inch. On the other side of the motor is a high-pressure vane pump, delivering 1·2 gallon per minute at a pressure of 2000 lb. per square inch. This complete pumping unit is mounted on a steel base plate, the lower portion of which is a tank with a capacity of 50 gallons, equipped with the necessary filters to ensure a clean oil supply.

The robust design of the whole machine is well shown in the photograph. To the left can be seen the pumping plant, and the electric leads for the electrically heated platens are also visible. The platens are 30in. square and are machined on their working surfaces, being milled to take the Bray elements. Thermostatic control of the platens is provided, and relays are mounted on the side of the press. In the right foreground can be seen the single operating lever already described, another noticeable feature being the main ram. The latter is made of close-grained cast iron, has a diameter of 17in. and a stroke of 14in., and works in a cylinder of cast steel. The gland has been designed with a view towards easy replacement of the packings. Daylight between tables is 25in., but can be altered to suit any particular job. At the working pressure of 2000 lb. per square inch the maximum load of 200 tons is exerted.

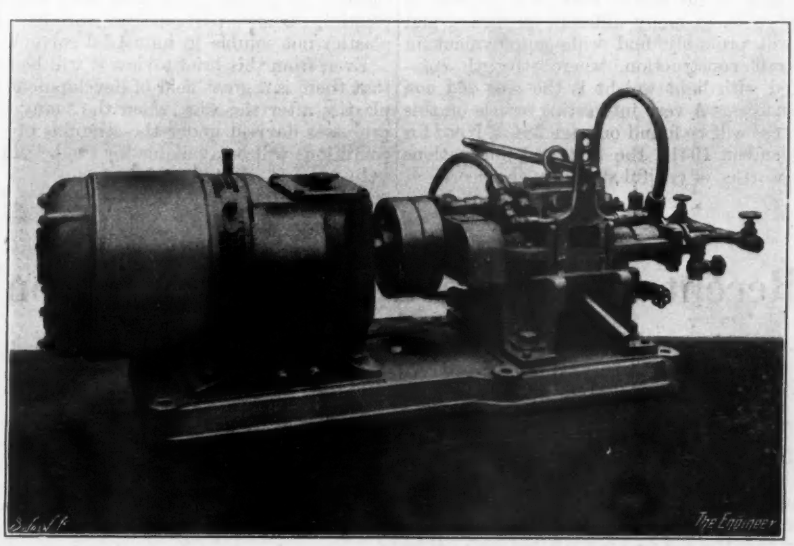

FIG. 4—MIXER FOR USE IN LABORATORY

Messrs. Daniels have devoted much study to the possible future development of plastics. For example, they believe that the special technique evolved for producing plastics for aircraft will be applied on a large scale to the furniture and household decorating trades. They also believe that injection moulding will be greatly improved and developed. So far, mouldings of this type have been of small size, and certain disadvantages have arisen, owing to the low temperature at which cellulose acetate softens. In their opinion, wide scope exists for improvements in the design of injection moulding machines. They foresee the future production of injection mouldings weighing pounds where they now weigh ounces.

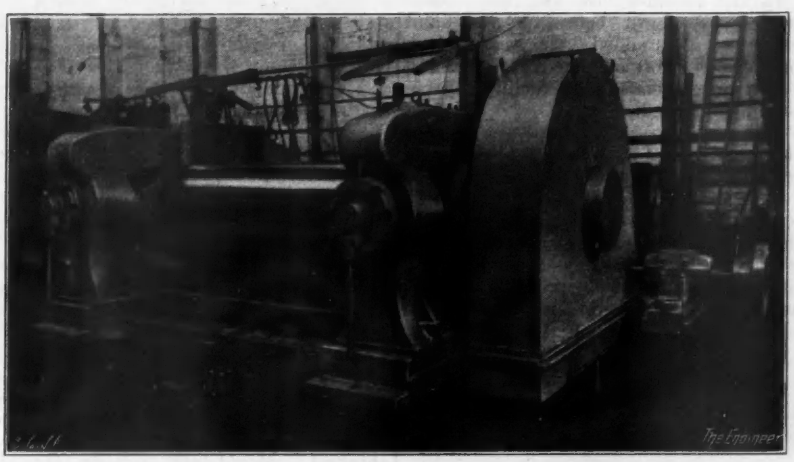

FIG. 5—SHEETING MILL

This firm quotes an interesting example from its own experience in the application of plastics to mechanical engineering practice. A moulded grooved cylinder is used as a jig or fixture for holding a saw chain during grinding. The cost of making this in cast iron, including the cost of machining, was about 27s., whereas the corresponding cost of the equivalent moulding in plastics was 3s. 6d. It must be emphasised, however, that such low unit cost can be achieved only where production is on a large scale. In this particular instance, the cost of the tools was £250.

Accurate and intimate mixing of the ingredients is another vitally important aspect of plastics manufacture. In the phenol and urea groups, for example, the maintenance of a constant temperature is an important factor in attaining high-quality manufacture. These substances will not work up if too cold, but will set up if too hot.

For many years David Bridge and Co., Ltd. (of Castleton, Manchester), have specialised in mixers for this type of work. Fig. 2 shows a No. 11 Bridge-Banbury mixer which has a mixing capacity of between 350 lb. and 400 lb. of ingredients in 10 min. The largest mixer made by this firm has a capacity of between 700 lb. and 800 lb. in the same period, and is driven by a 600 H.P. electric motor. The No. 11 model illustrated has a motor of 250 H.P., a length of 28ft., and a height of 14ft. 6in. Fig. 3 is a cross section of the mixer and clearly shows the operating principle. All ingredients are fed into the hopper while the machine is running. Mixing is then entirely automatic. The operator has the sole task of feeding the materials into the mixer at the proper time, discharging them when the mixing cycle is complete.

Accurate control of manufacture can only be achieved nowadays by eliminating, so far as is possible, the human element, and concentrating control in an automatic device. With every standard Bridge-Banbury mixer

a timing device and recording instrument are provided, by means of which close supervision of manufacture can be ensured. The timing device, for example, gives the operator definite instructions covering all types of stocks. Provided with a large dial and pointer, it is easily visible from the operating platform. A number of paper dials are furnished for each process or class of stock, and upon these are written the necessary instructions. A new chart is inserted in the timing device whenever there is a change in the day's run. Graded by minutes, they can be marked to show how long the rubber should break down before powders and accelerators are added, the time which should elapse before sulphur is charged, and the time or temperature at which the charge should be unloaded.

As mixing proceeds the pointer of the instrument moves forward in a clockwise direction. Contact arms, set to correspond to the marking of the charts, complete a circuit and flash a signal to the operator, either by lights or bells. Thus each stage of the process is accurately controlled and uniformity of finished product thereby assured. The record not only shows when each batch was started, but also the time and

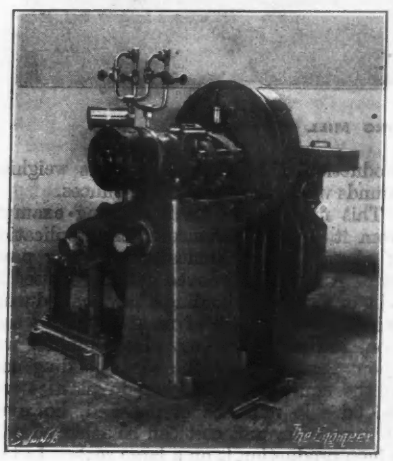

FIG. 6—PLASTIC EXTRUDING MACHINE

temperature of the entire mixing cycle. It also shows when the air-operated ram was lifted for the addition of a new charge, and whether or not it was held up too long. It also indicates the interval between batches, and is thus a positive check upon all movements of the operator. Reference to the charts will at any time show whether or not there was any deviation from the prescribed manufacturing process.

Controlling instruments are of two types—a recording thermometer and a recording controlling pyrometer operated on a potentiometer principle. The sensitive element of the recording thermometer must be encased in a stout, thick-walled metal socket, resulting in a time lag, and thus producing a record which is comparative rather than actual. After much research, it was found that the second type of instrument, operated on a potentiometer principle, was more sensitive than the recording thermometer, but at the same time quite as reliable.

In this instrument the sensitive element is a thermocouple installed at the bottom of the floating weight, or at some other point in the mixing chamber where it is in direct contact with the batch. An accurate and instantaneous reading is thus obtained to within 3 deg. or 4 deg. Remote control may be applied with such an instrument. It may also be used to control an electric circuit and cut off the current to the mixer motor when the temperature of the batch has reached a certain point.

Three further examples of plastics manufacturing machinery by David Bridge and Co., Ltd., are shown in Figs. 4, 5, and 6. The mixer shown in Fig. 4 is a laboratory model, suitable for mixing a batch of 3 lb. or 4 lb. in 10 min. It is a suitable size for research and experimental work. Fig. 5 shows a sheeting mill, which slabs and sheets out the stock after mixing. A typical plastic extruding machine is shown in Fig. 6. This is fitted with an electrically heated head and variable speed drive. It is particularly interesting in view of the wide use to which plastics are now applied for cable sheathings and insulation, to which the extrusion process is admirably suited.

From what has already been said, it is obvious that in general plastics are more suitable for small articles than for large ones, in view of the high cost of the dies. Great interest therefore attaches to the process devised and patented by Merron, Ltd., of Simplex Works, Bow, in which wood is used in the form of a veneer in conjunction with a synthetic resin. The process has been successfully employed for building dinghies, and bids fair to be applied to larger craft. A mould or templet, curved to the inside shape of the hull, is first fabricated. Strips of veneer coated with resin are then built up until the required thickness has been obtained. Mould and veneers are then covered with a thick rubber sheet, and a vacuum is created which draws the resin into the wood fibres. Mould and plywood are then placed in an autoclave, where an air pressure of about 80 lb. per square inch is applied. Simultaneous application of steam cures the resin in about 10 min. Pressure inside the autoclave forces the veneers together, and presses them accurately to the form of the mould. A hull of this type is stated to be produced more cheaply than one of conventional design, and is about half the weight. The monolithic character gives great strength and durability.

There is no doubt that this process is applicable to many different purposes, and it will probably find wide employment in aircraft construction, where strength combined with light weight is the *sine qua non* of success. A very interesting article on this process will be found on page 284 of *Wood* for November, 1941; the text and illustrations are worthy of careful study by engineers.

On April 15th last Major S. M. Mohr read an instructive paper to the Institute of the Plastics Industry, in which he referred to the rapid strides made by this new industry in the last twenty years. A development of particular interest to engineers is laminated plastic sheet, in which fillers are used, ranging from glass and asbestos to paper, cotton fabric, and wood. The author indicated what had already been achieved by mentioning that strengths as high as 40,000 lb. per square inch had been obtained with wood, paper, and straight fibre bases, and 23,000 lb. per square inch with cotton fabric.

Major Mohr then described a special application of plastics in which treated cloth, paper, or other base is wound into tubes. These range in size from ¼in. to 5ft. or even 6ft. in diameter, and in length from a fraction of an inch to 9ft. or 10ft. Secrecy prevented him from mentioning further developments, but he referred to the remarkable work done in connection with the National electricity grid system, which has in service a large number of high-voltage insulators made from synthetic resin-bonded paper. There are at present machines in this country which can manufacture high-voltage insulators up to a maximum length of 20ft.

He also mentioned the phenol-formaldehyde laminated plastics, of which perhaps bakelite is probably one of the best-known examples. Bearings, pinions, cams, jigs and assembly fixtures are well-known applications, and more recent developments are telescopic aerial masts, central mine tubes, and pigeon containers. Important wartime uses are also being found for cast resins, formed without pressure. The author stated that he believed that these substances would find a large field of development in the post-war world.

From an engineering point of view, a welding process described by Major Mohr should be of particular interest. This makes possible the fabrication of components from simple shapes, such as tubes, rods, and sheets. At present, it is used with thermoplastics, being particularly suitable for plastics not soluble in industrial solvents.

Even from this brief review it will be seen that there is a great field of development for plastics after the war, when the many new processes devised under the stimulus of war conditions will be available for the benefit of industry.

Recent Developments in Refrigeration*

By LORD DUDLEY GORDON, D.S.O., M.I. Mech. E. (Member of Council)†

No. II—(*Continued from page 405, November 13th*)

EVAPORATORS

FIG. 13 shows an evaporator of the shell-and-tube type, fitted with a dome for the separation of entrained liquid. It will be seen that the tubes are arranged in sections and that the end covers are fitted with baffles so that the liquid to be cooled passes through the different sections in series, thus increasing the velocity and improving the rate of heat transfer.

This type of evaporator is obviously not suitable where a large volume of brine has to be circulated, as in the case of an ice-making tank. In the latter case the tubes may be arranged vertically between top and bottom drums, the upper of which acts as a separator for entrained liquid. This evaporator may then be immersed in a compartment of the tank through which brine is circulated by a propeller. Fig. 14 is an arrangement commonly employed where the piping in which the refrigerant boils is in the form of horizontal grids welded into a vertical drum to which the liquid refrigerant is passed and from which the evaporated gas is drawn to the compressor. This form of evaporator is in notable contrast to the older type, which was almost invariably constructed of circular coils, arranged concentrically and contained in a vessel through which the liquid to be cooled was passed at a very low velocity, though an improvement was

* The Institution of Mechanical Engineers, November 6th. Twenty-ninth Thomas Hawksley Lecture.—Abstract.

† Chairman, J. & E. Hall, Ltd., Dartford.

sometimes obtained in older types by the provision of rotating paddles.

The evaporator frequently takes the form of an air cooler; indeed, the use of an air cooler in the form of a battery of piping over which air is circulated is becoming more or less standard practice for the storage of foodstuffs in land stores, and for their transport on boardship. This is a development of recent years, research work which has been carried out indicating that the formerly prevalent notion that certain foodstuffs must be kept, and sometimes even frozen, in a still atmosphere was wrong. All the recently constructed cold stores, and—later still—refrigerated ships are fitted only with air coolers.

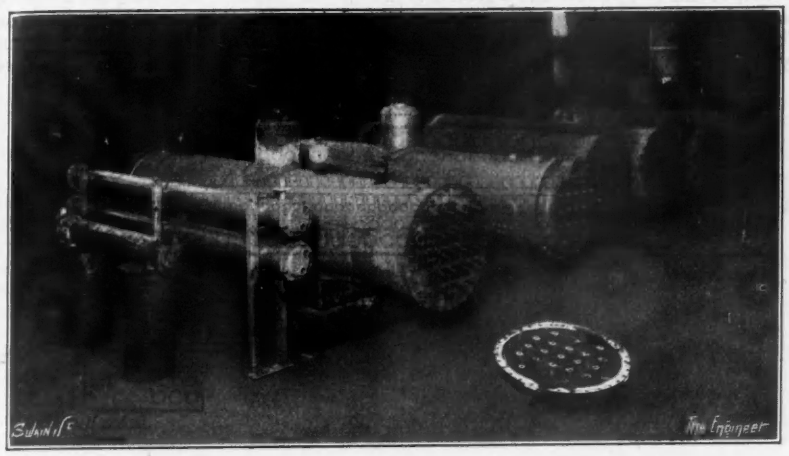

FIG. 13—*Shell-and-Tube Type Evaporators and Condensers*

In the early days of refrigeration the piping to act as an air cooler was arranged parallel to the flow of air, and in many cases no great attention was paid to the velocity of the air passing over this piping, nor were adequate arrangements made to ensure that the whole of the air would come into contact with the cooling surface. Within the last fifteen years this arrangement of piping has almost disappeared, and it is now the practice to arrange the piping at right angles to the air flow, in successive banks, which are staggered so that the whole of the air is brought into contact with the cooling surface and a sufficiently high velocity is maintained to effect a satisfactory rate of heat exchange.

Recent research has also shown the varying rates of heat transfer that can be expected with different conditions of the surface of the piping, either dry, wet, or coated with snow.

A common type of cooler, designed for use in a land cold store is shown in Fig. 15. It will be seen that this cooler is constructed with its own steel casing enclosing the piping in such a way as to leave no free passage for uncooled air. Such air coolers are provided with their own separator vessels to entrain free liquid refrigerant, as described for liquid cooling evaporators. To avoid the collection of snow on the piping, which will retard the rate of heat transference and eventually choke up the cooler, brine sprays are provided to keep the piping free of snow at all times. It is obviously important to prevent this brine from being passed through the air trunks into the cold chambers, so eliminator plates are provided at the end of the cooler.

This arrangement of brine spray has the obvious disadvantage that moisture from the atmosphere is condensed in passing through the cooler, and so weakens the brine. This has to be rectified by the addition of further calcium chloride, of which there may be a very heavy consumption in a large cold store. It is possible to avoid this heavy consumption by taking the brine to a separate vessel, where the excess moisture is evaporated and the strengthened brine is returned to the tray under the cooler. This operation is usually carried out by boiling the brine, the heat being obtained either by steam or electricity.

Serious trouble has in many cases occurred with brine concentrators owing to the very corrosive effect of weak warm brine, and an alternative arrangement has been tried. In this case the brine to be concentrated is not raised to a high temperature, but is passed over the condenser; the heat taken from the latter evaporates the excess liquid without bringing the brine to boiling point. The apparatus is kept in constant use so that the brine is maintained at a regular density without the use of any heat other than that which has to be removed in any case from the condenser.

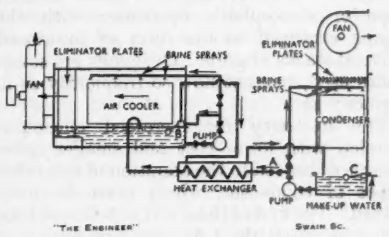

FIG. 16—*Circuit of Refrigerating Plant with Brine Concentrator*

Fig. 16 is a diagram of this arrangement. The condenser is contained in a casing and air is drawn through it by a fan. Valve A is set so that a fixed quantity of the brine circulated over the condenser is passed through the heat exchanger to the tray under the air cooler. Water condensed in the air cooler causes the float to rise and open valve B so that the excess, instead of passing to the brine sprays, is delivered back through the heat exchanger to the condenser tray. Either the whole condenser is used for evaporating the excess moisture or a sufficient section of it to ensure that the evaporation at that point will exceed the condensation occurring in the air cooler. Valve C, which opens as the float falls, makes up the difference between evaporation and condensation. The density of the brine in the condenser tray will always exceed that in the air cooler tray.

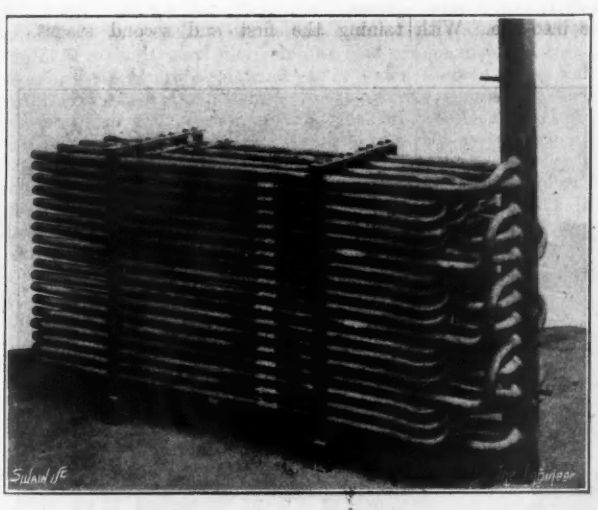

FIG. 14—*Oval Coil Brine Cooling Evaporator with Separator Pot at End; Flooded Type*

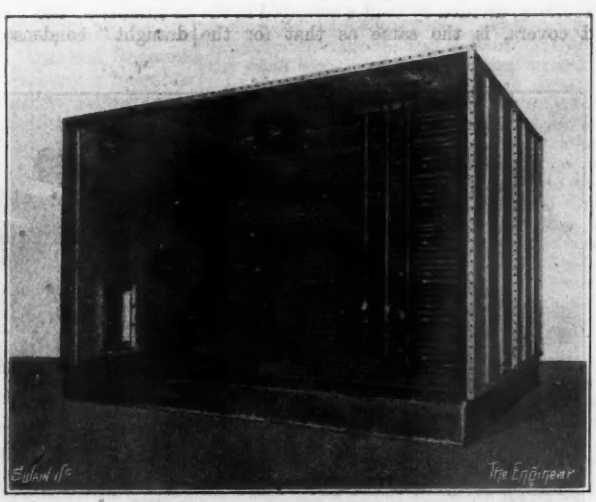

FIG. 15—*Brine Spray Cross-grid Air Cooler*

CONDENSERS

In the case of condensers the same development has naturally taken place as on the evaporator side; that is to say, the form of the condenser has been altered so as to

shorten the path of the condensing refrigerant and to improve the rate of heat transfer by means of higher velocities.

The original form of condenser usually comprised a helical coil or nested multiple helical coils contained in a cylindrical vessel through which the cooling water was passed. This involved the use of large quantities of water, and it was not long before the use of atmospheric type condensers became general, certainly for larger-size installations.

The amount of surface provided in the early days was much greater than would now be the practice with the present-day necessity for economy in expenditure and material. Fig. 17 shows a more modern type of atmospheric condenser with the piping arranged in the form of interlaced vertical stacks of grids. Oval coils are sometimes used, but not now so frequently as in former years.

The necessity for increased efficiency, coupled with lower cost and smaller space occupied, has led to the adoption of two other types of condenser, which must be mentioned. The first of these is the shell-and-tube type, in which the tubes are arranged in a single cylindrical vessel, similar to the arrangement already shown for the evaporator; or the condenser may be in the form of a number of smaller vessels through which the cooling water can be passed in series.

Where the water supply is such that the need for recirculating does not exist, as in the case of a dockside cold store, the shell-and-tube condenser is arranged vertically. In this case the water makes a single passage through the condenser tubes, being pumped from the dock to a receiving tank at the top of the condenser. This arrangement possesses the advantage that the tubes can be cleaned with rods while the condenser is in operation. Great saving of space is effected as compared with the open or atmospheric type, which has been commonly used in dockside plants in the past.

The horizontal type of condenser is similar to the evaporators shown in Fig. 13, but without a dome. The arrangement of the tubes in sections, divided by baffles arranged in the end covers, is the same as that for the evaporator, the water passing in series through the separate sections. This type of condenser is usually employed in conjunction with a cooling tower similar to that used for cooling water for steam condensers or the jackets of internal combustion engines, but with suitable modifications to provide for the much smaller temperature difference between the water and the air. With this arrangement efficiency is quite as good as, and sometimes slightly better than, with an atmospheric type condenser, whilst there is also some saving in first cost and a good deal of saving in space occupied.

The arrangement just described is particularly suitable in buildings where an open space is available either on ground adjoining the building, or sometimes on the roof, for the accommodation of the water cooling tower. In heavily built-over areas it is usually difficult, and in many cases quite impossible, to find a suitable position for the water cooling tower. The frequent adoption of air cooling plant, not only in industrial establishments, but also in large office buildings, created a demand for a large-size condenser which would be economical in the use of water and at the same time occupy little space, and so it came about that what is known as the "evaporative" or "forced draught" condenser came into use. With this type of condenser the condenser coils, frequently with gilled piping to increase the evaporating surface, are contained within a casing through which a sufficient volume of air is passed by means of fans to ensure the necessary evaporation of the water. Such a condenser may be placed in the engine-room, with ducting to lead the air to and from the unit, or it may be placed on the roof of a building.

Fig. 18 shows a section through a type of condenser specially suited for carbon dioxide as the refrigerant. It is designed for use on board ship. For this reason both casings and coils are of copper. The carbon dioxide passes in series through three spiral coils arranged concentrically in outer and inner casings. The diameter of the piping is reduced in each successive coil as condensation takes place. In the final coil, where the carbon dioxide assumes the liquid state, the velocity is maintained, so giving an improvement in heat transfer compared with a circuit having the same bore of piping throughout. The inlet and outlet terminals for the carbon dioxide are at the same end. At the opposite end the water is introduced; it first enters into the inner casing containing the final stage of the carbon dioxide circuit, and then passes back along the annular space containing the first and second stages. A

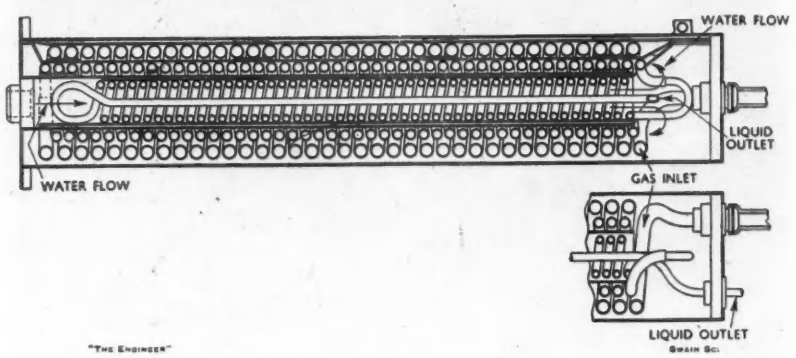

FIG. 18—*Carbon Dioxide Condenser*

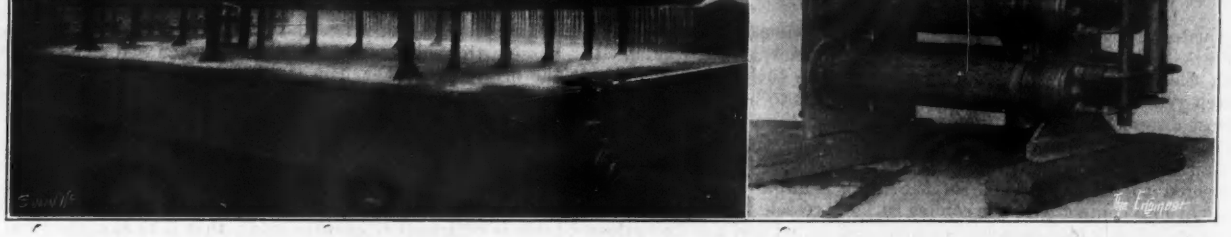

FIG. 17—*Atmospheric Condenser*

FIG. 19—*Copper Marine Type Condenser*

"contra-flow" effect is thus produced and again adds to the efficiency. The water velocity is sufficient to prevent the accumulation of sludge.

The unit described can be used singly or in parallel with a number of similar units, as shown in Fig. 19, to form a complete condenser of any desired capacity. The assembly illustrated occupies 117 cubic feet and weighs 3 tons 10 cwt., including the sea water passing through it. A condenser of the same capacity as that illustrated, but built of copper coils with a cast iron casing, in accordance with earlier practice, occupies 173 cubic feet and weighs 8 tons with its water. It also requires far more space when it has to be dismantled.

This arrangement is most suitable for carbon dioxide because in the case of that refrigerant so great a proportion of the condenser duty is performed with the refrigerant in the superheat region.

The Sponge Iron Process

THE granting to the U.S. Bureau of Mines of 600,000 dollars for the erection of two small-scale plants, for the experimental production of sponge iron at the rate of 30 to 50 tons per day, has brought to public attention once again some of the claims which have been made for this process during the past thirty years. *Iron Age* for July gave some account of the report upon sponge iron prepared by the U.S. National Research Council of the National Academy of Sciences, and an editorial note by Mr. J. H. van Deventer was strongly condemnatory of the process. One thing is evident, and that is that the sponge iron process is suitable for operation in small units, and it is visualised that reduction plants could be constructed at the mouth of every iron mine in the country. The consequence of this would be that "the concentrated control over the steel and iron industry which is now exercised would not be possible." It is not our intention to deal with factors such as this, which may be connected with the development (or lack of development) of the sponge iron process in America, but merely to review the essential technical features of the process.

The process is essentially the reduction of iron ore by the chemical interaction with gaseous carbon monoxide or hydrogen. The composition of the gas depends upon its source, which is usually the partial combustion of a carbonaceous fuel, such as coal or coke, but which may be natural gas or water gas. The exact quantitative relationship between the gas consumed and the ore reduced cannot be accurately expressed, as it depends upon the state of oxidation of the iron in the ore and the composition of the gas. Moreover, the carbon dioxide formed after reduction of the ore is subsequently reduced again by the excess carbon present to carbon monoxide, so that the net reaction appears to be the reduction of solid ore by solid carbon. However, the primary reaction with carbon monoxide or hydrogen could be expressed as follows :—

$$3\,CO + Fe_2O_3 \rightleftarrows 3\,CO_2 + 2\,Fe\,;\ \text{or}$$
$$3\,H_2 + Fe_2O_3 \rightleftarrows 3\,H_2O + 2\,Fe.$$

These reactions are gas/solid reactions, and as such their rates depend upon the surface area of the solid exposed. The heat balance of the process is, however, not properly described by these reactions, as much of the carbon dioxide formed is subsequently reduced to carbon monoxide before leaving the furnace, and heat is supplied by the combustion of the fuel *in situ* with the ore, as well as, in some modes of operation of the process, by external heating of the reduction furnace. The surface area of the ore is usually increased by preliminary grinding and mixing with the fuel, the mixture then being fed directly or after briquetting into a rotary kiln or stationary retort.

The temperature is so controlled that there shall be no fusion of the iron formed, and is usually in the region of 1000 deg. Cent. The product consists of a conglomerate of sponge iron in a very fine state of subdivision with sintered oxides and silicates from the ore and fuel ash. It is ground and the iron, separated either magnetically or mechanically, is compressed into briquettes and is then ready for melting down. The chief difficulty with these later operations is that iron in such a fine state of subdivision is pyrophoric, and the presence of a reducing gas is necessary to prevent oxidation. Even so, in the course of the subsequent handling of the briquettes considerable oxidation may take place, and difficulty may be met in the steel-melting furnace using sponge iron unless due allowance is made for the iron oxide introduced with it.

There is really nothing fundamentally new in the process. Reduction of iron ore in the upper part of the blast-furnace takes place similarly, but the iron is subsequently melted down with some 4 per cent. of carbon in the form of a fusible pig iron, and the gangue is melted down and separated in the molten state. The claims made for sponge iron are made chiefly on the grounds of purity of product (especially a very low carbon content), low maintenance costs by virtue of the relatively low temperature of operation, and the absence of erosive slags. These claims are disputed by the U.S. National Research Council of the National Academy of Sciences. It should be borne in mind that the open-hearth method of melting steel depends upon the easy melting of pig iron followed by subsequent heating, aided by the boiling down of the carbon of the bath. To offer as an alternative a bulky porous easily oxidisable material, such as sponge iron, having a melting point of about 1500 deg. Cent., is not likely to be welcomed. It is right therefore to consider sponge iron as an alternative to steel scrap rather than pig iron, and as such its claims for purity have a higher claim for consideration.

So far, the separation of the gangue from the sponge iron has not been complete, and slaggy impurities have been introduced into the steel melting bath by the use of sponge iron. On the face of it, the blast-furnace method of separating, as two immiscible liquid layers, the metal from the slag would appear superior for commercial operation to any magnetic or mechanical method of separation.

The method of preparing sponge iron is but an application of powder metallurgy, which is finding such useful application in the preparation of materials which have too high a melting point to be prepared by the conventional metallurgical operations. Molybdenum and tungsten have for a long time been prepared in powder form by the reduction of their oxides, the metals being subsequently subjected to compression under high pressures and to sintering at high temperatures. The production of the hard sintered carbide tool tips, which have proved themselves of such great value for machine tool operation, is also another application of powder metallurgy. These products of powder metallurgy always retain a certain degree of porosity, unless a fusible matrix is provided, and use is made of this property in the production of oilless bearings, which, when once soaked in oil, maintain lubrication by supplying from within the pores of the material. These highly compressed and sintered alloys, though less strong than melted alloys, may be pressed to the required shape, thus avoiding machining. The permanent magnet alloy, Alnico, can be well made in this way, as small intricate shapes are often required, and the material is very difficult to machine. Sponge iron and alloys prepared from it have been used for such articles as gear wheels, and even 18/8 stainless steel has been prepared in this manner. For articles where great strength is not required and intricate modelling is necessary for the cast material, it appears that the compressed powdered metal or alloy has great possibilities. As a raw material for steel melting, sponge iron seems to be of limited value; but in Sweden an excellent sponge iron is, or was, made by the Höganäs Company. The real difficulty is to secure a sufficiently high density, and if it could be overcome it seems that the process has possibilities. It is worth remembering, however, that the process is by no means new—the Höganäs dates from 1909 and was developed from much earlier inventions.

Tipped H.S.S. Tools*

By LEO J. ST. CLAIR†

Most machine shops have experienced breakage of solid high-speed steel tools. This breakage usually occurs on cutting tools of special shape, such as are used to machine a small section inside diameters or grooves. The hardening strains produced when a small section of high-speed steel abuts a larger section often cause the tool to break off through the small section when the cutting strains are applied. Tools that require sharp corners in their construction or tools that require a bending operation often are a source of excessive tool breakage also. A good example of tools where sharp corners are required are dovetail form tools. Such tools often break off at or near the inside corners of the dovetail. Offset tools for boring or grooving operations frequently require the bending of the tool shank and the strains caused by bending and subsequent hardening are often a cause for breakage. Large tools subjected to heavy strains also cause much breakage trouble.

The breakage of solid high-speed steel tools is eliminated by tipping the cutting edge area with a high-speed steel tip, and using a tough alloy steel for the balance of the tool. The General Tool and Die Corporation is producing such tools in large quantities by the use of its new process of tipping tools with hardened high-speed steel tips without affecting the hardness during the brazing operation. This company is constantly solving tool breakage problems by this method. The success attained by General Tool can be best explained by means of several sketches of tools where tool breakage has been overcome. For greater clarity, sketches of parts machined are also included.

A recent example of successfully solving a serious tool breakage problem by the use of tipped H.S.S. tools is shown in Fig. 1. This tool had to produce an undercutting operation in a tough alloy steel cylinder. The part

* From *Iron Age*, August 6th, 1942.

† President, General Tool and Die Corporation, East Orange, N.J.

machined is shown at A. The solid H.S.S. tool used to do the undercutting operation is shown at B, and the tipped H.S.S. tool that replaced the solid tool is shown at C.

The tipped H.S.S. tool was made by using an 8 per cent. cobalt H.S.S. tip $^{3}/_{32}$in. by $\frac{1}{4}$in. by $^{25}/_{64}$in., with a Rockwell hardness of 64–65 C. The tipped tools have been in use for two months with no breakage taking place. The tool life of the tipped tool averages three times the former solid H.S.S. tool. A 30 per cent. increase in speed is also being used over the former tool. This increased tool life and higher speed has been made possible by the use of the 8 per cent. cobalt H.S.S., which has a greater "red hardness" than the 18–4–1 H.S.S. formerly used, and also because of the two point increase in Rockwell hardness of the tip over the former solid H.S.S. tool. The user stated that the solid H.S.S. hardened to a hardness of 64–65 Rockwell C broke so often that he had to lower the hardness to 62–63 in order to reduce breakage.

The number of tools required per month was reduced from 300 solid tools to less than 50 tipped tools per month. This resulted in a saving of about 1500 dollars per month on tool costs, along with a 20 per cent. increase in output per day. This user has become enthusiastic about the tipped H.S.S. tools, and is rapidly increasing his use of this type of tool because of the longer life and the increased speeds secured over his former solid tools.

Another solid H.S.S. tool which caused much breakage trouble was used to cut a $^{3}/_{32}$in. wide by $\frac{1}{4}$in. deep groove in a S.A.E. 6150 heat-treated steel bushing. The tool breakage became so severe that the manufacturer attempted several times to have a milder steel substituted for the 6150 steel, but the user of this bushing refused to consider a substitute steel. The manufacturer dumped his problem in our lap, and we have been successful in solving it. In Fig. 3, sketch A shows the part being machined. The solid H.S.S. tool is shown at B, while sketch C shows the tipped H.S.S. tool.

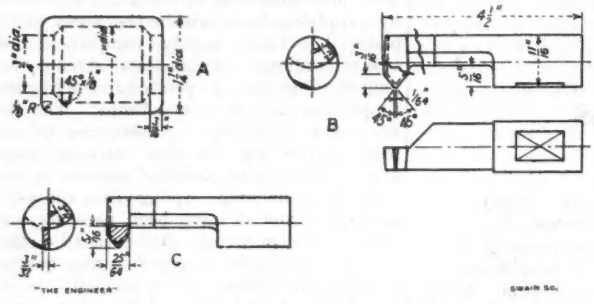

FIG. 1—*At A is the part to be undercut. At B is the solid 18–4–1 high-speed steel tool which had a tendency to break at the wavy lines. A tool tipped with an 8 per cent. cobalt H.S.S. is shown at C. Breakage has been eliminated*

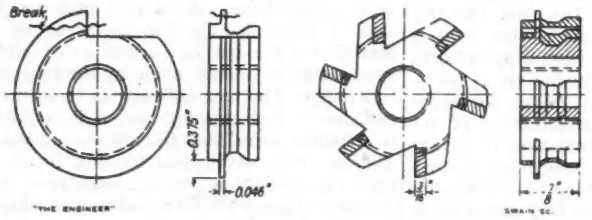

FIG. 2—*Six-tipped circular form tool used to replace a solid H.S.S. form tool that frequently broke as shown by the ragged line*

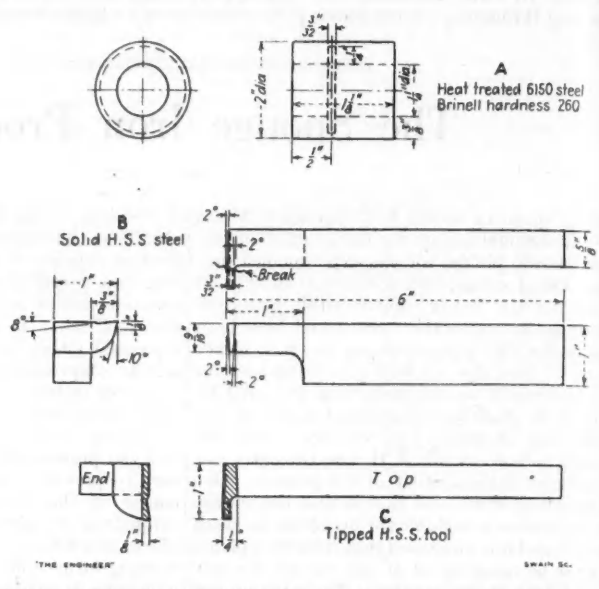

FIG. 3—*Grooving the S.A.E. 6150 steel bushing shown at A caused much breakage of the solid H.S.S. tool shown at B. The tipped tool shown at C, using 1/216th the material, gave almost three times the tool life per grind*

The solid tool in Fig. 3 was made of 18–4–1 H.S.S. with a Rockwell hardness of 60–62 C, while the tipped tool had a 5 per cent. cobalt H.S.S. tip with a hardness of 64–65 C. The solid tool's hardness had to be necessarily low in order to increase toughness of the narrow, weak cutting edge area, so that tool breakage could be brought down to reasonable limits. Since the tipped tool used a tough alloy steel as a support for the tip, we were able to increase the hardness of the cutting element considerably and hence increase tool life and cutting speed.

The operating data on both tools are listed below :—

	Solid H.S.S.	Tipped H.S.S.
Speed in r.p.m.	100	150
Feed per revolution, inch	0·001	0·001
Pieces per grind	30	80
Cut time per piece, min.	2½	1½
Production per hour ...	15	20

An analysis of the above table shows clearly the advantages secured by substituting the tipped H.S.S. tool for the former solid tool. An increase in production of 33⅓ per cent. was secured along with a real saving in tool cost. A total of thirty solid tools was required per month. Only eight tipped tools are now needed, resulting in a saving on tool cost of about 130 dollars monthly.

An interesting contrast is presented in the amount of H.S.S. required for each tool. The solid H.S.S. tool contained 6¾ cubic inches of H.S.S., while the tipped tool requires but $^{1}/_{32}$ cubic inch of H.S.S. (1in. by $\frac{1}{8}$in. by $\frac{1}{4}$in.). The solid tool contained 216 times as much H.S.S. as the tipped tool.

The internal recessing operation shown in Fig. 4 proved to be a very discouraging one with a solid H.S.S. tool. A recess, 0·125in. wide by $\frac{1}{16}$in. deep, necessitated a tool with a circular clearance on both sides of the cutting edge. The tool was rather expensive to build and difficult to harden without causing strains.

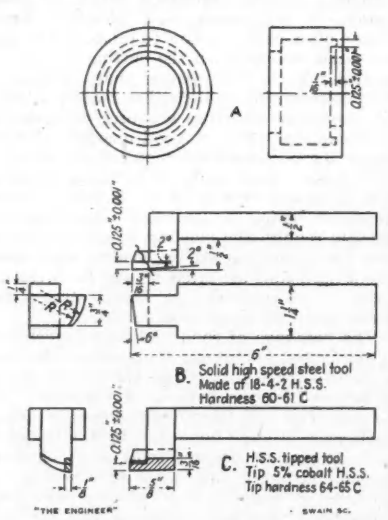

FIG. 4—*Another internal recessing job that was hard on the solid H.S.S. tool shown at B. The tipped tool shown at C uses less than 1 per cent. of the original material*

Sketch B, Fig. 4, shows the solid H.S.S. tool. Breakage usually took place at or near the ragged line. These tools cost the user 11·75 dollars in lots of fifty, and thirty-nine tools out of fifty broke before doing much work. The tipped tool replacing the solid tool is shown in sketch C. Ten of these tools were supplied, and so far none has given trouble. Again, a substantial increase in production is being secured due to the increase in hardness of the cutting edge and the higher red hardness in the 5 per cent. cobalt H.S.S. tip as against the 18–4–2 H.S.S. in the solid tool. The tipped tool required less than 1 per cent. of H.S.S., as compared to the solid tool.

The user of this tool presented us with another tough problem. This has to do with a circular form tool that has as part of the cutting edge an extension $\frac{1}{8}$in. deep by 0·046in. wide, which breaks off too easily. We felt sure that a circular form tool with six tips would overcome the difficulty. Fig. 2 shows the tool in question, and our method of solving the difficulty. The reason we planned to use six tips is that our tough alloy steel support is never very far from the actual cutting edge.

We were sure to increase tool life and speed due to the fact that the solid circular form tool necessarily had a Rockwell hardness of 61–62 C, while we planned to make our H.S.S. tips 63–64 hard. We also were going to use an 8 per cent. cobalt H.S.S. against the 18–4–1 used in the solid tool. The tipped tool cost about 30 per cent. more than the solid tool in this case, but we estimated we would reduce tool cost as much as 60 per cent. on this job, due to the tipped tool eliminating breakage.

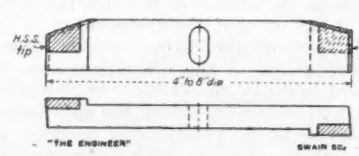

FIG. 5—*A considerable saving in tool cost has been obtained on this large fish-tail cutter by tipping*

The tool has now been in operation and has come up to and beyond our expectations. We have reduced cutting time about 30 per cent. by increasing speed 50 per cent. Pieces between grinds showed an increase of 300 per cent.

A remarkable saving in tool cost has been realised on large fish-tail cutters shown in Fig. 5. Hardening strains apparently weaken this type of tool and result in excess tool breakage. The heavy cutting strains that these

tools are subjected to present a real problem and this problem was met by the tipped H.S.S. tool. Moreover, we are able again to use a harder tip than the former solid H.S.S., and consequently tool life has been increased. Another interesting angle that is brought out by this tool is that the plant is now in the process of putting on new tips on the shanks that were originally tipped. This, of course, adds to the savings already realised. These worn tips are removed, new ones put on, and ground to the original o.d.

The plant is daily overcoming the troublesome breakage of dovetail form tools. We salvage those form tools that have not broken in the dovetail area during their useful life, and also salvage those where the dovetail broke on initial use. With the tipped tool, the dovetail is milled in the tough alloy steel shank, and hence breakage through this area is non-existent. Fig. 6 shows the construction of the

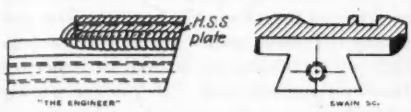

FIG. 6—*Troublesome breakage of dove-tail form tools is eliminated by brazing a H.S.S. plate on a low-alloy shank in which the sharp dove-tail is cut*

tipped H.S.S. dovetail form tool. We use this construction when we are called upon to furnish new dovetail form tools. We usually have the H.S.S. plate used for the cutting edge hardened to 64–65 Rockwell C without any fear of trouble. By necessity, the solid dovetail form tool is usually two to three points softer than this. Hence the tipped H.S.S. form tool of this type will give a considerably longer tool life.

A recent application has resulted in a fine increase in tool life and a real reduction in costly breakage. This tool is a planer tool used to make a deep recess in a cast iron part. It was formerly made out of a solid piece of 18–4–1 H.S.S., 19in. long, 1in. wide, and 2in. deep. Fig. 7 shows the tool as tipped with an

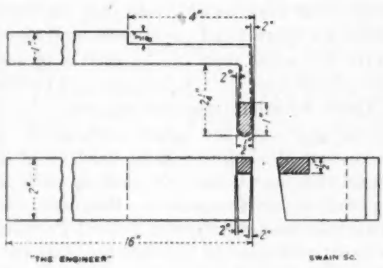

FIG. 7—*Tipped planer tool used to make a deep recess not only saves scarce material but also reduces costly breakage*

8 per cent. cobalt H.S.S. tip 1in. by ¼in. by ¼in. Here are comparative data :—

	Solid 18–4–1 tool.	8 per cent. cobalt tip.
Hardness, Rockwell C ...	60–62	64–65
Quantity of H.S.S., cubic inches	38	¼
Average tool life, hours ...	1	5

In other words, the solid tool uses 152 times more critical material than the tipped tool. In addition, the breakage difficulty has been solved.

In all cases of tipping with hardened H.S.S. tips, the use of valuable H.S.S. is drastically reduced. Apart from this saving of vital cutting tool material, many tools are far superior as a tipped tool as compared to a solid tool from a construction standpoint. The much greater strength of the tipped tool definitely entitles it to serious consideration whenever tool breakage is pronounced with the solid tool. Also the fact that we can usually have a tip of H.S.S. somewhat harder than the corresponding solid tool entitles the tipped tool to serious consideration from the tool life standpoint, and the consequent tool cost reduction that ensues. This new tipping process definitely points to new design thoughts for many types of troublesome tools.

American Engineering News

Magnesium Production

The increasing demand for magnesium metal supply in the United States, as required in several war industries, has led to enlarged production by existing works and also Government support for the exploitation of new sources and processes. The mineral dolomite is gaining in interest over the richer magnesite, owing to the far greater abundance of the former. In the brine recovery process sea water as a source has an active competitor in the richer magnesian brines of Texas and Michigan. Another development which is now in its earlier stages is the recovery of magnesium from the silicate mineral "olivine" and its close associate serpentine. Vast deposits of these minerals exist in the Pacific coast region of Puget Sound, and in the mountains of North Carolina. Of several raw materials from which magnesium is obtained, the highest in rank is brucite, with a content of 40 per cent. But this material is limited. Olivine has a content of 28 to 30 per cent., together with nickel; magnesite has 28 per cent.; dolomite, 12 per cent.; brines, 1 to 2 per cent.; and sea water, 0·13 per cent. Attempts at acid-leaching of these magnesian-nickel ores showed that the magnesia as a by-product was of more value than the nickel. Difficulties in dealing with the gelatinous silica and other hydrates were obviated by the simple expedient of neutralising the reacted mass before leaching. The liquors resulting from lixiviation of the neutralised mixture are almost free from residual acid and of impurities which accompany acidity. The large deposits of olivine in the Western State of Washington and the Eastern State of North Carolina are in regions favourable for cheap hydro-electric power supply, transportation, climate, markets, and labour supply.

Truss Work in Steel Buildings

In a number of large multi-storey steel-frame buildings in the United States large open spaces free from columns in the lower floors are made possible by spanning the space with steel trusses—sometimes two stories deep—which carry the interior columns of the upper stories. A recent example is the thirty-storey Mercantile Bank at Dallas, in which the main banking floor is on the second storey, or the storey above the ground floor. In order to eliminate all columns in a space of 61ft. wide and 160ft. long, this space is spanned by 50-ton trusses, 61ft. between centres of supporting columns. They are 14ft. 6in. deep between centres of chords, these chords being included in the steel framing of the fourth and fifth floors. Thus the open space is clear from the second to the fourth floor levels. Design of the trusses and arrangement of the web members was complicated by the requirement of an opening 18ft. wide and 10ft. high in the central panel. Columns for the framing of the twenty-six-storey superstructure are seated on the top chords of the trusses. Heavy gusset plates connect the trusses to their supporting columns, which thus have to carry a load of about 1200 tons, plus 60 tons direct wind load and 460,000 foot-pounds of wind moment. The columns are seated on rock at 50ft. below the street level. Each consists of a 14in. rolled H-beam, weighing 426 lb. per foot, with a 16in. by 2in. plate riveted to each flange, and four outside angles, 8in. by 4in. and 1in. thick, to which the 1in. gusset plates are riveted. To minimise the weight of the building the floors are of very light construction, weighing only 25 lb. per square foot. This weight includes the steel beams and suspended ceilings. The floor proper consists of cellular steel framing covered by a 2½in. concrete slab in which expanded mica forms the aggregate.

Oil-electric Ship Propulsion

Development of A.C. equipment for ship propulsion has involved a number of problems which have been worked out by the co-operation of American naval engineers and electrical engineers, so that of two oil-engined submarine tenders one has an A.C. propulsion system, while the other has the older D.C. system. Both have A.C. for ship's service. This is the first A.C. application for propulsion on a naval vessel and also the first use of synchronous motors for propeller drive. The propelling machinery is in two duplicate sets in separate compartments. Each group has four oil engine generator sets, a propulsion motor, an excitation motor generator set, and a control unit. The generators are rated at 1150 kW, 95 per cent. power factor, 2400 volts, 759 revolutions, three-phase, 62·5 cycles. Two of the generators are for propulsion only, and are excited from a separate motor generator set. The others have D.C. exciters and can be used either for propulsion or for parallel operation with the regular ship's service generators during periods of high power demand for submarine servicing. The two synchronous propulsion motors are of 5900 H.P., 2400 volts, three-phase, 62·5 cycles, at 139 r.p.m. Each motor is directly connected to its propeller shaft. Variation of propeller speed between normal full speed and 25 per cent. of normal is obtained by regulation of fuel supply to the oil engines. When operating in parallel, the adjustment is made simultaneously on all the engines. Transformers in conjunction with the propulsion generators supply additional power for ship's service. The total connected load may reach 6000 kW, and the service load 2500 kW. A.C. equipment has advantages for large naval propulsion systems, as D.C. generators and motors are limited to relatively low voltages.

United States Land Reclamation

The storage of water for reclamation of arid and semi-arid lands by irrigation, and use of excess storage for hydro-electric power development is being carried on actively by the United States Bureau of Reclamation, which organisation has recently celebrated its fortieth anniversary. The fortieth annual report showed that about a million people—both farmers and townsfolk—now reside on the present fifty-three reclamation projects in seventeen of the western States, while more than 4,000,000 acres of irrigable land have been reclaimed or saved from abandonment. The food, forage, fibre, and water produced are essential war commodities, although alfalfa, sugar beets, vegetables, and other crops have not the same public appeal as guns and tanks. Multi-purpose irrigation projects are providing the electric energy, the water, and the man power essential in keying agriculture, mining, and manufacturing to vital war developments. The Bureau's first hydro-electric plant was built in Arizona in 1906, but it has now twenty-eight such plants in eleven States, with an aggregate installed capacity of 1,365,462 kW. By the end of 1942 this capacity will have been increased to 1,770,000 kW, while by the end of 1945 it will have reached 3,207,000 kW. For its construction work in 1943 the Bureau has requested a Government appropriation of £22,000,000. For 1942 it had estimated £25,000,000, but Congress reduced this by some £4,000,000 in eliminating certain projects whose relation to war activities was comparatively small. The vast number of dams includes large and small structures; concrete gravity, concrete arch, and multi-arch, earth embankments and loose rock embankments. One peculiar activity of recent development has been the provision of residential centres for Japanese evacuated from cities along the Pacific Coast to interior points.

TYRES AND SURFACES.—The Director of Highways in Kansas, U.S.A., has initiated a scheme to determine what the vehicle operating savings would be if driving in that State were entirely over well-paved roads. To that end he proposes to have stock cars driven over thousands of miles of paved and unpaved surfaces. Detailed costs will be recorded for each item which makes up total car operation costs on each road type. While earlier studies have shown as high as 2c. per vehicle mile saved when driving over paved roads rather than unbound earth or gravel, the Director of the Asphalt Institute, which is watching the experiments, points out that, at only 1c. per mile saving, the 600,000 car drivers of Kansas lose 6000 dollars in tyres and cars each time they all ride over 1 mile of unbound earth or gravel.

The Engineer

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NOTICES TO READERS

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

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CHANGES OF ADDRESS

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DESIGN AND PRODUCTION

THE Eighteenth Report from the Select Committee on National Expenditure for the session 1941–42, published only last week, seems to be a little bit behind the fair. We suspect that it has, so to speak, been "delayed in transmission" and that it has been touched up to bring it into line with recent happenings. Its major theme is that unless there is co-ordination between design and production output will be delayed. The Committee records its general impression that "in recent months a great many steps have been taken which, if they are properly followed up, and if the right men are found to fill the key appointments, should have the effect of materially improving war efficiency in the vitally important matter of providing the Fighting Forces with the right weapons at the right time." We are perhaps not far wrong in associating this statement especially with recent changes in the organisation for the production of tanks.

It is an axiom of mechanical engineering production that a close *liaison* between the drawing-office and the shops must always exist. One of the first things that is impressed on the young draughtsman is that he must think how things are to be made, and in not a few cases he has to make his designs fit in with the machine tool capacity of the works in which he is engaged. Evidence is not wanting that in certain Government undertakings this axiom has been ignored. Design has been carried out without consultation with manufacturers, and specifications have, not infrequently included changes which may have appeared trifling on the drawing-board, but which caused delays by involving modifications of tools and equipment. Furthermore, it is common experience that alteration in the design of one part of a machine often affects many other parts. When design and production are under single, individual management, such things as these are watched very carefully. A private firm working for a profit cannot afford to run the risk of enormously increasing its costs, and perhaps incurring a fine under the penalty clause in a contract by delays in delivery. But a design department working under a Government is not tied by these considerations. Hence it is prone to make changes in specifications without considering the effect upon the manufacturers. Delay inevitably results. It is not denied that changes are essential from time to time to meet the exigencies of warfare. But it is submitted that such changes should not be made on the fiat of a design department alone, but only after consultation with constructors. The Committee shows its appreciation of this fact which has been common knowledge to engineers since the drive for war materials began. It lays down as a general principle that "in the case of certain important instruments of war, such as tanks (including all that goes with tanks), there should be set up a complete functional organisation with one man—in the position of a managing director—at the head, carrying a clear and unified responsibility for organising and directing all the activities that go to produce the finished article, *i.e.*, (i) research, design, experimental work, tests, and trials; (ii) production; (iii) progressive modification and adaptation in the light of practical experience."

Was it Napoleon who remarked that one indifferent general was better than two excellent ones? Hitherto, we have endeavoured to produce certain war materials under the direction of two generals, one responsible for design and the other for production. Whether both of them were "excellent" for the work in hand need not be discussed at this juncture. The fact is that dual direction caused delays which would have been avoided by unified control. It is to be hoped that changes effected within the last few weeks, to which the Committee refers, will have the effect of removing quickly some of the obstacles which have up to the present hampered production. The household saying that "too many cooks spoil the broth" was never truer than at the present moment. Many cogent arguments for the unified control of our Fighting Forces have been presented, and there is no reason to doubt that the successes which in the past few weeks have blessed the arms of the United Nations are due in a large measure to the adoption of that principle. Is it not a logical deduction that similar unification would—or let us now say will—have equally good results in the field of production?

Engine Stamina

IT is commonly regarded as axiomatic that ascertained facts form the best foundation of theory. Indeed, many theories have been slain by facts, and we do well to remember Huxley's remark that "If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere, but if you are absolutely and persistently wrong, you must some of these days have the extreme good fortune of knocking your head against a fact, and that sets you right again." Among notable collectors of facts are those companies which make it their business to insure machinery against breakdown, and in a paper recently read by the engineer of an American insurance company, it was stated that while, with steam engines, there was an accident-frequency ratio of 1 to 11, the ratio for I.C. engines was 1 to 3·5. It cannot be doubted that the most vital requirement in any prime mover is that it shall be reliable, and the main objective of all engine builders should be the production of engines of high stamina. The merits of design and workmanship can only be determined by operational experience, and this is where the experience of the user is of such vital significance for the designer and builder.

These considerations are suggested by an examination of the paper submitted on November 5th, before a joint meeting of the Diesel Engine Users Association and the Institution of Locomotive Engineers, the chair being occupied by Mr. Bulleid, President of the Institution of Locomotive Engineers. This paper, which we are reprinting, contains an account, by Mr. C. R. Parker, of experiences with railcar oil engines in the Argentine, and was read, in the author's absence, by Mr. A. K. Bruce. All the way through, it is a commentary on the importance of stamina in oil engines, and an exposition, almost in parallel columns, of what the author describes as the "preventive maintenance" essential for the satisfactory working of railcar engines. The Ganz engines, which are the subject of the paper, certainly provided ample scope for the practice of "preventive maintenance," and they wrung from the author the caustic comment that "there is no reason why engines should be employed which require the crankshafts re-bedding, head joints, &c., re-facing, and new auxiliary bearings throughout after only 70,000 kiloms." Such are some of the consequences of lack of stamina, which is a condition—or rather a disease—not confined to Hungarian and German engines, though, as it seems, epidemic on certain railcar engines of Continental manufacture. If the railcar oil engine is to prove a dependable piece of equipment

it must be more robust than the engines described in Mr. Parker's admirable paper. Some of the speakers in the discussion were outspoken in their support of the author's strong recommendation that the power plant of a railcar should be mounted on the underframe and not on the bogie. This is a matter only to be tested by experience, and Mr. Parker has stated his experience with complete frankness and, as it seems to us, lack of bias. But whether the engine goes on to the underframe of the car or is mounted on the bogie, it must be a right good job, and we cannot see how it is likely that an engine of what Mr. Parker calls the "reduced scale" marine or stationary type (in contradistinction to the enlarged automobile type) can be mounted anywhere else than on the car underframe. No mention was made either in the paper or in the discussion of the horizontal *vis-à-vis* type of railcar engine, largely used by the *Reichsbahn* after—and perhaps in consequence of—long experience with the Maybach vertical bogie-mounted engine. The German horizontal engine was standardised for large-scale production, and its speed was round about 750–900 r.p.m. Such an engine is extremely rugged, and we wonder why it is that there has been no recent aggressive development of the type in Great Britain.

But whether the engines are vertical or horizontal, diagonal or upside-down, the makers will do well to pay attention to that ancient saying: "Who hath despised the day of small things?" Had the makers of the engines dealt with in Mr. Parker's paper given more consideration to the means for ensuring trouble-free operation, there would have been less need for providing, with the engines, special maintenance personnel for wet-nursing them. Ultimately, it seems that Mr. Parker had to organise, *de novo*, the maintenance technique, removing, at the same time, the causes of certain recurring troubles. That craftsmanship by itself is not enough can be well confirmed by the precautions found necessary in the maintenance of aircraft engines. Without craftsmanship plus vigilance, "Per Ardua ad Astra" would be just a pious expression. So it must be with all British engineering products, since if ever they should lose their reputation for stamina, the end will be in sight, and our manufacturers will follow at the funeral of their own reputation.

A Great Physicist

By M. SCHOFIELD

ENGINEERS were particularly interested in commemorating the birth of Lord Rayleigh on November 12th, 1842, since this giant among physicists contributed so much to a science which is one of the foundations of engineering. Rayleigh completed an eminent Cambridge sextet, taking his place along with Cayley, Adams, and Stokes, with Thomson, who interpreted the Second Law of Thermodynamics, and with Maxwell, who studied the kinetic theory of gases. As Sir Arthur Schuster* pointed out, Rayleigh was ripening just when Faraday was at the end of his years; when photography was in its infancy, the Bunsen burner but eight years old, and electrical discharges through vacuum tubes were first being studied. Such astonishing versatility had he that no one could but be fascinated by the experimental work of this craftsman, who took such simple apparatus "of wood, wire and wax" and worked wonders with them. His name is associated with both academic subjects and with such everyday objects as the gas-filled electric lamp and the siren which wails in our streets by night.

Rayleigh bought his first apparatus in 1868 and died in 1919. For fifty years without interruption, without sign of any deterioration, this leading physicist put forth his polished papers—about 400 of them, and each one worth consulting for the matter in it and not merely as a milestone in following his scientific researches. Unlike Faraday, he had means to enable him not only to devote so many of his years to experimenting, but to purchase from the start any apparatus required. Rayleigh could never find out from his Cambridge professor where he could purchase apparatus similar to that used in demonstrations; always the reply was indecisive, or "the man he bought it from was dead." But he devised his own, adopting everyday mechanisms at times to answer a particular purpose. At Terling, his home and laboratory, a few pieces of glass tubing and sealing wax could be made to work wonders. Experiments on the resonance effect of sound vibrations were carried out with bottles held over an old grand piano. When the new gas argon was to be isolated on a larger scale than hitherto, Rayleigh was able to borrow a permanent magnet alternator from a fellow-physicist, but the rest was his own: a 3 H.P. gas engine, source of power for a centrifugal cream separator in his old brewhouse, and the cream separating vessels to hold the caustic soda when absorbing the nitrous fumes.

Though Rayleigh's wide contributions have been divided into various periods, one visualises them more clearly to-day when they are placed in three divisions. There were his works in general physics; his special interests in sound; and his discovery of argon in the air. In 1868, with his Grove cells, a sparking coil, and other odd pieces of apparatus, he conducted his first experiments on electromagnetism. His interests in electrical problems were wide, and his first choice of subject for setting in motion the new Cavendish Laboratory later was the re-determination of electrical standards, a work of extreme value to industry, as were so many of Rayleigh's experiments. This was the essence of Rayleigh's work: always to improve every subject he tackled; always to see what was essential in every problem and to present the results crystal clear, "unaffected by the cloud of prejudice." His mind has been compared to a filter, since things were clearer after passing through it. In almost every branch of physics one comes across his contributions. Flow of liquids through capillary tubes; formation and stability of water jets; the blueness of the sky and the effects of dust particles in scattering light (with the use of fine sulphur precipitates in place of Tyndall's dust particles); experiments on colour vision and Maxwell's colour top—such are but a few examples in his five volumes of collected papers.

As an exercise on the German language, Rayleigh read Helmholtz's classic work on acoustics and became himself one of the pioneers in that new subject. He realised the importance of this branch of physics more than some teachers of to-day do, who permit examinees either to take a short cut through the syllabus or to leave sound out altogether. It proved a subject which inspired him to great achievement, both in theory and in practical application. His treatise on the theory of sound, begun on a Nile journey with no library available, takes its place along with the classics of Thomson and Tait, and of Maxwell on other branches of physics. (Anticipating paper economy, he wrote it on the backs of worked papers of candidates for the Cambridge Tripos of that time!) Rayleigh's study of resonating bodies came early and improved on the work of Helmholtz, who had made a whole series of vessels resounding to notes of various pitches. Next came the problem of how the ears are able to distinguish the direction from whence sounds come; of the limits or audibility and of echoes. When Rayleigh's attention was drawn to a peculiar echo which arrived a whole octave higher in pitch than the original, he was not baffled, but pointed to a plantation of fir trees as the cause, the branches being obstacles of the right dimensions compared with the wavelength, so as to suppress the fundamental and permit the octave harmonic to return with predominant intensity. The history of the siren, one form of which is now so familiar, cannot be told without the vital chapter contributed by Rayleigh. It was Cagniard de Latour, that mild little Frenchman, who studied bird calls and musical instruments and wrote serious memoirs on whistling, who gave us this "banshee." Others had thought of puffs of air blowing through revolving perforated discs; de Latour substituted the wind chest with revolving disc on top and with a series of holes cut at an angle. This form, still to be seen (and heard) when exuberant schoolboys study practical acoustics in the laboratory, was the parent of the siren, which as fog signal saved the sailor rather than lured him to legendary destruction. De Latour was followed by Holmes, who made a siren with such "diabolical ear-splitting noise" at the Paris Exhibition of 1867 that the authorities banned it. In 1895 Rayleigh became scientific adviser to Trinity House and for a number of years made trips on the yacht of the Elder Brethren to test fog signals. In 1901 he tried his new disc siren with a "better æsthetic effect" at St. Catherine's, in the Isle of Wight; but, as he remarked, the "whoop" of the old siren was still "the best part of the whole" and could be heard 10 miles away. Rayleigh tried bells, steam whistles, and trumpets before the siren, fitted with the Rayleigh horn for spreading the warning note horizontally over the sea, became the only efficient source. Those who have heard in foggy weather the horns at Alderney, Flamborough, Whitby, and elsewhere know well the success attained by a Trinity man in the service of Trinity House.

The discovery of argon, Rayleigh's crowning achievement, was his only venture into Chemistry House. But with what success! Cavendish started the tale with his little bubble of inert gases left after sparking air and removing oxides of nitrogen; Rayleigh took up the story over a century later, using equipment on a larger scale which inspired the Norwegians to build up their industrial process for nitrogen fixation. For over a century chemists had ignored a new constituent of the atmosphere literally under their

* "Proceedings," Royal Society, XCVIII A. 1921.

noses, nor would they believe in it when Rayleigh had prepared a thimbleful. So there came this grand, exhausting experiment in the old brewhouse at Terling, typical of Rayleigh's thoroughness and determination. With his gas engine, dynamo, transformer, and sparking apparatus working for a whole week, with Rayleigh and his laboratory steward watching on alternate shifts while over 700 c.c. of oxygen and nitrogen were absorbed per hour, he prepared 65 c.c. of argon, costing "a thousand times its weight in gold." Yet even after publication of the Royal Society paper there were sceptics. "I want to get back again from chemistry to physics as soon as I can. The second-rate men seem to know their place much better." Such was Rayleigh's parting shot.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE STATUS OF ENGINEERS

SIR,—We all seem to be agreed that the moral capacities of our fellow-men are inadequate for the forces and the opportunities of exercising them which the engineer has developed and provided. Engineers have been busy contributing these, but have not found their way to control their functioning. Whether this has been through indifference, lack of imagination, or as a consequence of vocational training instead of generous education, or of all three, is another question. As the attitude of mind of the public towards engineers and engineering changes, our social force will be greatly enhanced. This will take time, but will come here as it has done elsewhere, and in the meantime we must convince the public that we are accurate, practical, and constructive people on whom they actually must rely.

Captain Edgar Smith certainly takes a high line in thinking that engineers should not ask for favours, but should go into Parliament themselves if they wish to direct the country's activities. Would this not be a case, in the majority of instances, of a man going into a business to which he had served no apprenticeship and had no training? Now and then the exceptional man is found who can undertake work without preliminary training routine, but it is unusual. This perhaps crystallises a point which is rather nebulous in Dr. Inglis' address as to what it is exactly that engineers want in the way of better status.

As regards the Services, it is unnecessary to go over the ground when we have such glaring examples as the heads of the Navy and Army engineering staffs being only a Vice-Admiral and a Major-General respectively, when there are so many less vitally necessary people Admirals of the Fleet and Admirals in the Navy, Field-Marshals, Generals, and Lieutenant-Generals in the Army. Coming to the commercial world, it will be found that as a general rule in a well-organised firm the head of that firm and his staff, or most of them, have served an apprenticeship or pupilage or been articled to a firm practising that particular profession or business. It will also be found that although there are many engineers in a colliery, to cut the coal, elevate it, to ventilate, pump and light the mines, &c., yet a colliery owner is the head of the undertaking. In the same way there are engineers in a cotton mill, to keep the spindles revolving, to condition the air, and so on, but a cotton spinner is the head of the organisation. In a shipowner's office the superintendent engineer controls the activities of the engineers at sea and in port, but a shipowner is responsible for the movements and activities of his ships. If the engineer goes to sea, he becomes the technical adviser in engineering matters to the master mariner, who is in charge of the ship and who has served an apprenticeship as a seaman. In an engineering works the same rule holds good. The accountant may dissect, analyse, and produce the accounts; the chemist and metallurgist advise regarding the use of materials employed; representatives of other professions and businesses may play their part; but an engineer will be the head of an engineering works and his co-directors will probably have had the same training. The control of production has tended to be removed from engineers to financiers, who are apt to regard the engineer as a necessary nuisance, but in any firm largely dependent on the efficiency of its technical side, the status of the engineer should be that of a director. The reason for this is that, as a director, a wider view is necessarily taken of the firm's requirements, based on the wider knowledge of the factors involved which include the justifiable expenditures and the necessary economies. Further, a director is supposed to have greater security of tenure than an employee, and if this is so, he then has greater freedom in expressing his opinions frankly, even though they may be unpalatable to other of his colleagues. An employee with a directorate containing strong men of opposite views is almost bound to try to avoid antagonising either of his chiefs.

While only one who has been trained in the specific work should become the final directing authority, others who have been trained in matters vital to the industry ought to have a voice in the decisions made.

If engineers had the opportunity of such training and experience, and were untrammelled in expressing their views, expense might be spared and unnecessary waste avoided.

STERRY B. FREEMAN.

Birkenhead, November 16th.

EDUCATION OF SONS OF ENGINEERS

SIR,—A fund has been registered under the War Charities Act, 1940, for educating at Cheltenham College the sons of engineers who lose their lives as a direct result of the war, whether they are in the Services or are civilians. In the past similar steps have been taken to provide for the sons of doctors, clergy, and other professional classes, but so far as I know little has been done for the sons of engineers.

This is an engineers' war. All the fighting units depend for their efficiency on the engineer, both as part of their own strength and in the factories, supply services, transport, and mines. I can think of no better way of showing our gratitude to all engineers than by giving generously to this war charity. I am therefore writing to ask you to bring forward this fund to the notice of your readers. Donations, large or small, should be sent to me [Field-Marshal Sir John Dill] at the registered address of the fund, "The College, Cheltenham," cheques being made out to "The Cheltenham College Fund for Sons of Engineers."

J. E. DILL, F.M.

British Joint Staff Mission Offices of the Combined Chiefs of Staff, Washington, November 2nd.

COAL OUTPUT

SIR,—Can a new approach be made to the question of coal output? Miners value leisure as well as money, probably, because of their working conditions, to a greater extent than any other class of worker. Hence there is likely always to be a fairly large amount of absenteeism. If more leisure could be made the reward for output, perhaps this would prove a greater incentive than more money.

It should be possible to give each mining district a target figure, the achievement of which would represent a satisfactory output. The target might be the present one or, if need be, a higher. The district figure could then be subdivided so that each pit had a target. When a pit had reached its weekly target, work for the week could finish. The free time would not then be absenteeism, meriting reproach, but properly earned leisure.

The proposal may be impracticable, but I believe that the incentive value of leisure is much underrated. A fixed week and a wage varying with output have been standard practive since industry began. There may be cases where a fixed output with more leisure as the incentive for a higher rate of output would produce better results. I think it is quite possible that in some cases a higher output would be obtained on this basis than would be obtained by making more money the sole incentive. The method would not be generally applicable in industry, but it might be applicable to such things as mining and dock labour.

D. S. ANDERSON, Principal.

Birmingham Central Technical College, November 11th.

Sixty Years Ago

INTERNAL COMBUSTION ENGINES

IN our issue of November 17th, 1882, we reported that Herr Beck, of Nordhausen, Germany, had been granted a patent for an engine of which the motive force was to be supplied by gunpowder. In a horizontal cylinder a piston was set in motion by small quantities of powder ignited alternately before and behind it. The gaseous products escaped through slide valves, while the heavy residuum accumulated in the deepest part of the cylinder and was pushed by the piston into receptacles which were emptied from time to time. The powder was ignited by a spirit flame or gas jet, which was sucked through an opening provided with a slide valve. It was added that a Cologne firm was about to undertake the manufacture of Herr Beck's engine. . . . In our succeeding issue, November 24th, we recorded that Professor Schottler had recently made some experiments with an engine constructed by a Hanoverian firm which used petroleum as fuel. The petroleum flowed from a closed reservoir through pipes in which there were two slide valves and one cut-off valve. It united with air introduced by a pump cylinder. After being compressed the mixture was forced into the working cylinder and ignited. It was stated that the working cylinder had a diameter of 8in. and the pump cylinder a diameter of 6½in., the stroke of both being 14 $\frac{1}{16}$in. In the course of four trials a maximum of 4½ H.P. was developed with the engine running at 130 r.p.m. The consumption was returned at 1¾ to 2½ pints of petroleum per horsepower per hour. This consumption excluded the petroleum used for the "kindling flame," which was fed from a separate reservoir. It was found that in regularity of working the petroleum engine was superior to a gas engine. We quoted a German contemporary for the comment that even if the petroleum engine did not seriously compete with the gas engine, there were many cases in which its special advantages might be found useful. However, it was added, the storage of quantities of petroleum was attended with risks of fire, which might restrict the use of the new invention.

BELGIAN RAILWAYS.—Despite the German occupation—perhaps by reason of it—the Belgian National Railways, during the first six months of 1942, conveyed 85,300,000 civilian passengers, an increase of more than 50 per cent. over the figures for the same period in 1941 (54,900,000). The mileage travelled rose from 1,723,000,000 kiloms. to more than 2¾ million kiloms. On the other hand, goods traffic declined, due to the country's decreasing industrial activities.

Smoke as Guide to Boiler Control

By MICHAEL FIELDEN

AS one who has spent untold hours performing the relatively tiresome task of analysing chimney gases by means of an Orsat apparatus, and who has in later years stood back during boiler tests to gaze leisurely at the chart of an automatic recorder, the writer is in a position to pass on certain observations which at least should prove of value in the present attack on fuel waste. It is a proud moment when one has balanced the combustion taking place in the furnace and flues of a boiler burning hundreds of pounds of bituminous coal or heavy fuel oil each hour, a condition which is attained when the stack-gas analysis shows the maximum carbon dioxide and the minimum free oxygen compatible with clean combustion and non-sooting of water and steam-back surfaces. And from experience, it can be said that a simple observation which can be made by the least technically minded of boiler attendants will prove in most cases as useful as the involved process of gas analysis. In fact, combustion engineers proceed, *a posteriori*, from this simple observation to the accompanying manually or automatically made analysis.

Briefly, there is a critical point in the balancing of the supplies and ratio of primary and secondary air which coincides with the optimum thermal efficiency, which is manifested by a slight haze at the chimney outlet. To give an idea of this condition, a boiler consuming 400 lb. of coal an hour will develop its highest practical thermal efficiency with the emission of appreciably less smoke than is shown at the chimney top of a house in which 4 lb. of coal is being burnt hourly in the domestic grate, the coal in each case containing upwards of 33 per cent. combustible volatile matter. The smoke emission should be no more than is required to produce a distinguishable haze, otherwise an undesirable degree of sooting of the cooler surfaces will occur. Wherever practicable, a suitably placed mirror in which the chimney top can be seen from the boiler house or some convenient nearby position, should be consulted by the stoker at frequent intervals. In most cases it will be found that this arrangement offers little difficulty.

As the combustion performance of an oil-fired boiler is more easily kept on a straight line, and as the principle behind the smoke-haze method of control applies equally to fuel oil and bituminous coal, both being potential smoke producers, it will prove useful to consider first the results of such control as reflected in the waste gas analysis. A typical heavy oil, showing by ultimate analysis about 85 per cent. carbon and 13 per cent. hydrogen, is calculated to give a theoretical maximum CO_2 content of 15–16 per cent., measured by volume in the dry gases. With a trace of smoke at the chimney outlet, the stack gas composition would be as follows :—CO_2, 13–13·5 ; O_2, 2–2·5 ; CO, 0·3–0·5.

The mean of the above analyses figures out to a supply of oxygen equal to 3 lb. per lb. of carbon, as compared to the 2·67 lb. of oxygen theoretically required for complete combustion. Thus the air excess, based on the carbon content of the oil, is 13 per cent. Taking the hydrogen content into consideration, and this element is seldom incompletely burnt in the case of oil, the excess of air is, in the typical example quoted, rather less than 10 per cent. These figures indicate the remarkably high efficiency of combustion obtained when the critical point at which smoke is just distinguishable at the chimney outlet is taken as the criterion of optimum performance.

Burning coal with about 5 per cent. hydrogen content, the stack-gas analysis under the conditions described would be as follows :—CO_2, 14–14·5 ; O_2, 4·5–5·0 ; CO, 0·25–0·35.

Taking the theoretical maximum CO_2 as 18·2 per cent., the mean excess air is equal to 25 per cent. above the quantity needed for complete combustion, this figure taking into account the hydrogen content which is typical of bituminous coal mined in Britain. Considering the difference in surface/mass ratio between atomised oil and the usual grade sizes of lump coal, the result obtained is better than might be expected. Certainly, with properly designed boilers and good stoking, the combustion described will result in high thermal efficiencies. Pulverised coal, is, of course, comparable with oil. In regard to the effect of size of lump coal within the limits of common practice, as also to the manual and automatic methods of stoking, the gas analysis given above needs little correction.

Smoke has been shown to serve a useful purpose, the only one outside of warfare and the "curing" of certain commodities, but it may be said to have one other redeeming feature when considered in relation to boiler practice and thermal losses. It is visible and literally shouts its presence from the chimney tops. To clear the smoke by means of an increased supply of air, by stronger draught, or reduced rate of combustion, is to introduce an invisible loss, which is invariably higher than the 1·5 to 2·5 per cent., resulting from the range of CO previously quoted. In fact, without the aid of gas analysis, it is largely a matter of chance whether the excess of air over theoretical requirements is increased to 50 per cent. or even 100 per cent., undesirable conditions which with coal firing would be reflected by CO_2 readings of about 12 and 9·5 per cent. respectively. The high thermal losses are too great a price to pay for any advantage which may be derived from the complete elimination of smoke. As already indicated, the sooting of boiler surfaces when a trace of smoke is taken as the guide to the most efficient operation is of so small an extent that it can be termed negligible. Hence, whether or not gas-testing instruments are installed, the critical stage at which smoke is just visible at the chimney outlet presents the best and most practical guide to economical operation.

Balanced draught, brought about by intelligent adjustment of the various dampers provided and check observations of the smoke emission, is generally coincident with a small positive pressure in the fire-box, a condition which can be felt by slightly opening the fire-door. Where doors are light in weight and catchless, particularly with oil firing, the optimum thermal efficiency is often accompanied with a quite distinct vibratory rattle caused by the periodic release of pressure. However, these signs are complementary and may coincide with an undesirable excess of smoke. At the same time the relation of these vibrations to the smoke emitted can prove of value to an observant stoker.

Needless to say this note is not intended to be a eulogy to smoke. Neither is it meant to suggest that gas analysis is an unnecessary procedure in boiler-house practice. It is offered as a practical contribution to the attack on fuel waste. Smoke, in the very small quantities referred to, is shown to be a useful index to thermal efficiency, an index that is available with or without the technical aid provided by analysis of the chimney gases. And as many boiler houses are not as yet equipped with gas-testing devices, it is hoped that the information given will prove of value. In conclusion, it should be said that the statements and claims made are based on a fundamental condition, that of good stoking.

Bituminous Coal for Stoker-Fired Stoves

WHILE the use of domestic or residential heating furnaces having mechanical stokers is general and increasing in the United States, the effective use of bituminous coal as fuel for furnaces of this class is hampered by the fact that in the process of combustion such coal becomes plastic, evolves volatile gases, and then hardens into coke. This coking tendency interferes seriously with complete combustion. Through the co-operation of coal mining companies, commercial coal associations, and the manufacturers of stoker furnaces, a study of combustion in such furnaces has been made at the Pennsylvania State College and has resulted in a modified design of furnace which is practical and economical, according to a paper presented by Professors C. C. Wright and T. S. Spicer, before the American Institute of Mining and Metallurgical Engineers. It is to be noted that residential heaters are those classed as burning not more than 60 lb. of coal per hour.

The character of the coke thus formed in the furnace varies, of course, with the character of the coal, and if the coke is of too strong a structure it has a low rate of burning and a slow response to the heat demand. In extreme cases it may lead to extinction of the fire. The plastic mass, also, prevents uniform distribution of air through the fuel bed, and with strongly coking coals large dense pieces of coke are produced, which have much less reacting surface than that of the original coal. It is pointed out by the authors that in both the ignition and combustion of solid fuels the extent of the reacting surface is an accelerating factor. Poor combustion permits a surplus of fuel to accumulate in the furnace, because the rate of feed and the rate of combustion are not in equilibrium, with the result of an unbalanced condition detrimental to continued automatic service.

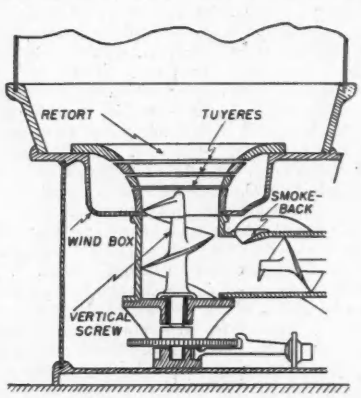
Domestic or residential combustion equipment has a difficulty in meeting the problems due to the variations of different bituminous coals in ash and volatile matter, ash clinkering tendencies, coking properties, and particle sizes. Study by the Bituminous Coal Research Association indicates that of these factors the coking properties and clinkering tendencies have the greatest effect upon the operation of the clinkering type of stoker.

The basis of the improvement for the combustion of bituminous coal is the modification of the coking properties of strongly coking coal by its pre-oxidation, which is produced by the intimate mixture of air with the green coal in the retort of the stoker. In the conventional or typical design of underfeed domestic furnace, to which this modification has been applied, a horizontal screw conveyor feeds the coal from the bin or hopper to a short vertical screw conveyor, which carries it up into the retort forming the base of the furnace. The air for pre-oxidation is supplied under pressure to a wind box feeding to openings below the top of the screw. This construction is shown in the accompanying drawing. It was considered that beside the reduction of segregation and de-gradation derived from the vertical screw, the coal would be so agitated that the air would come in contact with most of the coal before a material rise occurred in its temperature. Without the pre-oxidation air the use of a vertical screw has little or no effect upon the coking properties of the fuel.

A single fan supplies the wind box as well as

the regular tuyères arranged around the retort and above the top of the vertical screw. The wind box pressure may range from 0·6in. to 1·2in. of water, which is the range normally encountered in domestic stokers. The pressure will depend upon the relative resistance of wind box openings and tuyères, the resistance of the fuel bed, and the resistance of the column of raw coal above the wind box openings. As a result of the improved condition of the fuel bed when operating with pre-oxidising air, the fuel bed resistance is usually decreased sufficiently to compensate for the increased resistance introduced by the pre-oxidising openings and the column of raw coal.

As to the oxidation of coal, the report points out that coal combines with oxygen at ordinary temperatures if exposed for a sufficient time. It begins to absorb oxygen slowly until the temperature reaches 120 deg. Fah., the absorption then proceeding more rapidly until 175 deg. to 280 deg. Fah., this second stage depending upon the quality of the coal, its particle size, and other factors. The third stage differs from the second in that CO_2 and water vapour are given off increasingly as the temperature rises to about 450 deg. Fah., above which point the



UNDERFEED STOKER

oxidation is spontaneous and does not require heat from an outside source. Actual combustion or kindling of the coal takes place at about 660 deg. Fah., and coal then continues to burn vigorously as long as air is supplied.

A general conclusion presented is that modification of the coking properties of strongly coking coals, so that they can be burned efficiently in domestic furnaces, may be obtained in underfeed stokers by the intimate mixing of air for pre-oxidation with green coal in the retort of the stoker when operating at its normal temperature. Experimental work indicates that this modification is accomplished an inch or more below the zone of active combustion and at a temperature as low as 300 deg. Fah. Application of the modifications to different stokers has demonstrated that the idea is practical, resulting in improved combustion efficiency and response to heat demand, as well as holding the fire. Improvements in fly ash and in clinker formation, which are influenced more by retort design and ash removal methods, are subjects for further research.

Aerodrome Construction

In a report by the Select Committee on National Expenditure, just published, questions connected with aerodrome construction are discussed and the following recommendations made :—

(1) The Air Ministry should consider more carefully the time that it will take to complete each contract, having regard to the various factors which are likely to cause delay to the work.

(2) The Ministry should consider the advisability of inviting contractors to tender on a wider basis.

(3) Before any future work is undertaken by the Ministry, time and progress schedules should be prepared by the contractor and lodged with the Ministry.

(4) More attention should be given to the importance of avoiding, once construction has begun, any alteration in plans which is not absolutely necessary.

(5) The date for the completion of a contract should be agreed upon by the Air Ministry and the contractor in consultation; penalties for failure to complete works within the contract time should be strictly enforced, and a bonus should be paid for early completion.

(6) The Ministry should ensure that plans for new aerodromes are completed and finalised at an earlier stage than in the past.

(7) Workmen should be encouraged to live on aerodrome sites by making the camps more attractive and comfortable.

(8) Steps should be taken to ensure that disciplinary action against workmen for misconduct or absenteeism be taken as speedily as possible.

(9) Men with the necessary technical knowledge should be stationed at ports and goods stations to avoid losses and delays in the transport of machinery to aerodromes.

(10) Arrangements for *liaison* between the department of the Ministry in charge of plans and the department responsible for the supply of equipment should be improved.

(11) The Ministry should adopt a system of priority for completing aerodromes.

(12) The remuneration of resident engineers should receive the attention of the Ministry.

(13) Consideration should be given to the Air Ministry undertaking all aerodrome construction for the Government.

(14) Land otherwise unused should be cultivated at all Royal Air Force stations.

University Naval Courses

It is announced by the Admiralty that with a view to accelerating the provision of a large number of officers needed by the Royal Navy as the Service expands, the Admiralty has decided to institute short University courses, which will start early in 1943, for candidates for naval commissions. The new scheme is generally similar to those which have been in force for some years for the Army and the Royal Air Force. Courses are to begin in January, April, and October next, at the Universities of Oxford, Cambridge, Liverpool, Cardiff, Edinburgh, and Glasgow, at which a Naval Division exists. Candidates, who must be between 17½ and 18½ on the 15th of the month in which their course starts, will be selected by a board sitting for that purpose from those recommended by the headmaster of the school at which they are or have been attending. Those who have already enrolled under the "Y" scheme and those who have already been interviewed as candidates for Special Entry and were unsuccessful, but were awarded 150 marks or more at their interview, will not be interviewed again, but a medical examination must be passed. Selected candidates will be given a six months' course, during which the cost of tuition and board, lodging, and medical attention will be borne by the Admiralty. They will also undergo training in the Naval Division. Those candidates who reach the necessary standard will be recommended for commissions, and their subsequent period of probationary training will be shorter than that for ordinary entrants. Full particulars and instructions with regard to this new scheme can be obtained from all naval centres.

The Retirement of Sir Thomas Biggart

At the annual meeting of the Central Board of the Shipbuilding Employers' Federation, held in Carlisle on November 13th, and referred to elsewhere in these columns, it was announced that Sir Thomas Biggart, an Hon. Vice-President and Consultant to the Board, had decided for health reasons to relinquish these offices after half a century's association with the work of employers' organisations in the shipbuilding industry. Mr. Biggart became secretary in the early 'nineties to the Engineering Employers' Association in the West of Scotland, and later was appointed secretary of the Clyde Shipbuilders' Association and of the Clyde Dry Dock Owners and Ship-repairers' Association. He was actively associated in the early movements of both shipbuilding and engineering employers' associations, out of which two important national organisations emerged, the Shipbuilding Employers' Federation and the Engineering Employers' Federation, and was for some time secretary of both these bodies. He held similar appointments also with the Clyde ship-repairers, the dry dock owners and ship-repairers of the United Kingdom, the Scottish bridge builders and structural engineers, and other employers' associations. Two other organisations with a nation-wide membership in the development of which Sir Thomas played a prominent part were the Iron Trades Employers' Insurance Association and the Foremen's Mutual Benefit Society. Sir Thomas is senior partner in the firm of Messrs. Biggart, Lumsden, of Glasgow, and a knighthood was conferred on him in 1936. Appreciative reference was made by the Shipbuilding Employers' Federation to the great work which Sir Thomas had done for the industry. The meeting conveyed to him its congratulations on so distinguished a career, and its very cordial thanks for his services to shipbuilding and ship-repairing during so many years of active association with the Board's deliberations.

BOOKS RECEIVED

Temperature Control. By A. J. Ansley. London: Chapman and Hall, 11, Henrietta Street, W.C.2. Price 13s. 6d. net.

The Structure of Steel Simply Explained. By E. Gregory and E. N. Simons. London: Blackie and Son, Ltd., 66, Chandos Place, W.C.2. Price 5s.

Engineering Materials, Machine Tools, and Processes. By W. Steeds. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 16s. net.

Boiler Plant Technology. By R. L. Batley and E. G. Barber. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 15s. net.

The Materials of Aircraft Construction. Fifth edition. By F. T. Hill. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 20s. net.

Electrical Engineering Practice. Vol. 2. Fifth edition. By J. W. Meares and R. E. Neale. London: Chapman and Hall, 11, Henrietta Street, W.C.2. Price 35s. net.

Handbook of Heating, Ventilating, and Air Conditioning. By J. Porges. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 17s. 6d. net.

District Heating in the United States of America. Articles reprinted from *The Steam Engineer.* London: John D. Troup, Ltd., 90–91, High Holborn, W.C.1. Price 5s. net.

Roads and Road Construction: Year Book and Directory, 1942–43. London: The Carriers Publishing Company, Ltd., 1, Bridge Place, Belgrave Road, S.W.1. Price 12s. 6d. net.

Simplified Electrically Heated Hotbeds. By C. A. C. Brown and E. W. Golding. London: British Electrical and Allied Industries Research Association, 15, Savoy Street, W.C.2. Price 1s. net.

Factory Lay-out, Planning and Progress. By W. J. Hiscox. Third edition. By J. Stirling. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 7s. 6d. net.

Manipulacion Mecanica de Mercancias (Manuales de Ingenieria). By W. H. Atherton. London: International Publishing Company, 39, Parker Street, Kingsway, W.C.2. Price 8s. 6d. net.

Standard Handbook for Electrical Engineers. Seventh edition. Edited by Archer E. Knowlton. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 56s. net.

The Telephone Handbook. Eighth edition. By J. Poole, completely revised by N. V. Knight and W. Prickett. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 25s. net.

Railcar Oil Engines in the Argentine*

By C. R. PARKER

Introduction

In these notes an endeavour will be made to describe the methods of oil engine repair and overhaul as practised at the locomotive works of the Central Argentine Railway, and to give details of rates of engine wear and troubles experienced that are likely to be of interest to this Association.

Type of Engine.—The engines selected as the

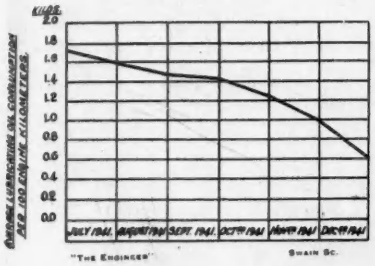


FIG. 1—*Decline in Average Oil Consumption*

subject for these notes were manufactured by Messrs. Ganz, of Budapest, and have the following characteristics :—

Cylinder arrangement	Vertical
Number of cylinders	Eight
R.p.m.	1350
Maximum service, B.H.P.	365
Cylinder bore...	170 mm. dia.
Cylinder stroke	240 mm.
Piston speed, feet per minute ...	2130
B.M.E.P., lb. per square inch ...	79
Weight per B.H.P. lb.	21

These engines are used for the propulsion of twelve twin articulated railcars equipped with mechanical drive, supplied by the same firm, and constitute the principal passenger railcar service of the Central Argentine Railway. Six spare power units were purchased, making a total of thirty engines in all for this service.

The engines have been de-rated to a maximum output of 320 B.H.P. at 1250 r.p.m., the speed range being 800–1250 r.p.m. under load and 400 r.p.m. idling. The general design follows that of an enlarged road vehicle type of power unit.

Fuel and Lubricating Oils.—The details of the fuel and lubricating oils used are given in Table I.

A streamline filter is used in the running shed for lubricating oil cleaning, and fuel oil is filtered by fine mesh strainers, the main supply tank being fitted with a floating suction pipe.

Engine Performance.—In service the average fuel consumption is about 40 kilos. per 100 engine kilometres. On test, after overhaul, the consumption varies between 171 grammes and 173 grammes per B.H.P. per hour at the rated output of 320 B.H.P. at 1250 r.p.m. In service, lubricating oil consumption has varied considerably. When the engines were new the individual consumption was from 1·0 kilo. to 6 kilos. per 100 engine kilometres, the average figure for all engines being of the order of 2·0 kilos. per 100 engine kilometres. The original scraper rings consisted of a simple bevelled ring at the bottom of the piston skirt and a double bevelled ring just above the gudgeon pin. The introduction of a slotted or ventilated type of ring designed and manufactured in the Railway Company's own shops has reduced the oil consumption considerably. This now varies between 0·2 kilo. and 0·3 kilo. per 100 engine kilometres. At the time of

TABLE I.—*Fuel and Lubricating Oils*

Fuel Oil	
Specific gravity at 15·5 deg. Cent.	0·851
Flash-point (Pensky Martens) ...	68 deg. Cent.
Viscosity (Redwood) at 38 deg. Cent.	36 seconds
Ash	0·004 per cent.
Water and sediment	Traces
Conradson carbon...	0·037 per cent.
Sulphur	0·59 per cent.
Distillation at 350 deg. Cent. ...	92·0 per cent.
Aniline point	63·9 per cent.
Gross calorific value	11,050 calories
Diesel index	51
Lubricating Oil	
Specific gravity at 15·5 deg. Cent.	0·93
Flash-point (Pensky Martens) ...	218 deg. Cent.
Viscosity (Redwood)—	
At 38 deg. Cent.	877 seconds
At 99 deg. Cent.	71 seconds
Viscosity index	82
Conradson carbon	1·02 per cent.

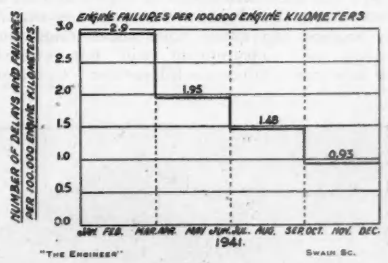


FIG. 2—*Decline in Service Delays and Failures caused by Engine Defects*

FIG. 3—*View of Railcar Engine Repair Bay from Outgoing End*

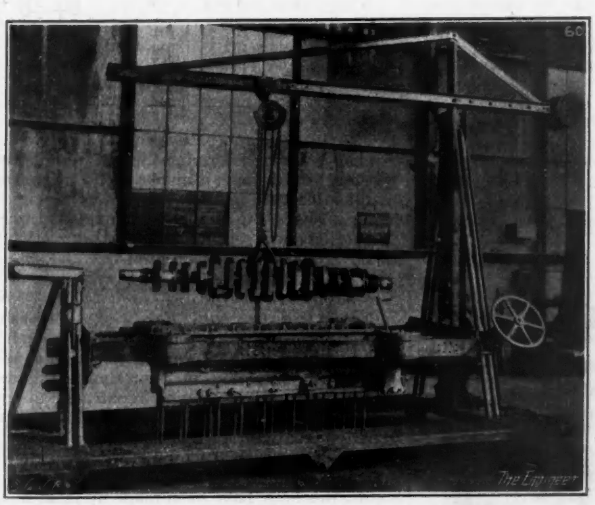


FIG. 4—*Special Engine Repair Trucks*

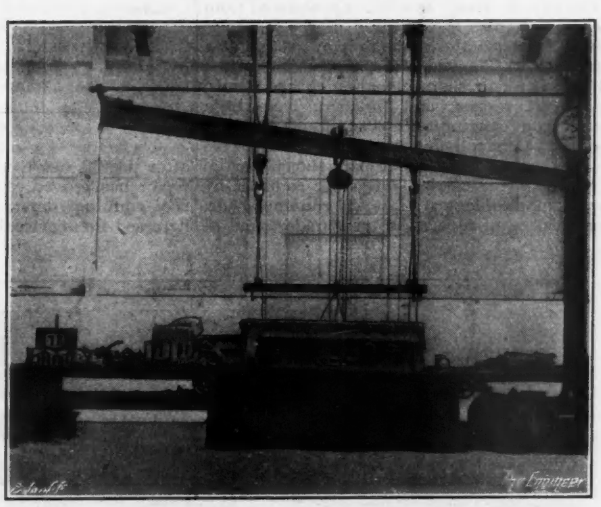


FIG. 5—*Engine Part Cleaning Boshes*

* Joint meeting, Diesel Engine Users Association and Institution of Locomotive Engineers, November 5th, 1942.—Abstract.

writing, all engines have not yet been fitted with these rings, but the decline in the average oil consumption of all the engines in service since these rings were introduced is shown in Fig. 1. There is not the slightest doubt that when all the engines are fitted with these rings the average oil consumption will not exceed 0·4 kilo. per 100 engine kilometres. Cylinder wear has not increased since the oil consumption was reduced, neither has ring or groove wear increased to any appreciable extent. Considerable improvement in the condition of valves, piston rings, combustion chambers, &c., is experienced, due to the reduced carbon deposit. Further details of these rings will be given when the question of piston rings in general is dealt with later in these notes. Up to the time of writing (January, 1942) the engines have completed a total of approximately 13 million kilometres.

Repair and Overhaul Policy.—On the Central Argentine Railway full use has been made of the existing plant at the locomotive repair shops. The benefits derived from the selection of this site are many, as will be appreciated from these notes, also the location of the works is suitable to serve the whole railway system at a future date. The whole of the personnel of the oil engine repair shop, including charge hands, inspectors, testers, and foremen, have been drawn from existing railway staff and specially trained. Originally only general repairs were undertaken at the main repair shops, partial overhauls being carried out under contract by the engine builder's staff at the running sheds. Both classes of repairs are now undertaken at the main repair shops. This change in policy has proved to be exceptionally sound. Reliability has been improved and the running department has been relieved of responsibility for engines. The benefits derived from having only one organisation of engine specialists will be still further enhanced as the number of running sheds increases. Fig. 2 shows the decline in delays and failures due to engine defects since the partial overhauls were undertaken at the main repair shop.

Testing, running-in, and tuning up engines after partial overhaul as well as after general repair has proved essential. This also relieves the running department, who are usually harassed for serviceable units, of the necessity for engine tuning and nursing on the track, which in any case is unsatisfactory. The establishment of a definite kilometrage between engine overhauls has also played an important part in improving reliability. In practice difficulties with other parts of the units sometimes prevent engines being withdrawn for shopping precisely when due, but all efforts are made to adhere as closely as possible to the prescribed kilometrage. Well-organised preventive maintenance is essential for satisfactory working on railways. Details of weak and unreliable design determine the periods between overhaul until such time as the necessary modifications are made. Temporary repairs at running sheds are costly and unsatisfactory. The periods now established between overhauls for the engines in question are :—

Partial overhauls, kiloms.	75,000
General repairs, kiloms.	200,000–225,000

Repair and Overhaul Facilities.—The shop originally used as the locomotive paint shop has been taken over for internal combustion engine work, and a section of this shop has been arranged for railcar engine repair, on a progressive basis. Fig. 3 shows a view of the railcar engine repair bay from the outgoing end.

Most of the special facilities with the exception of a cylinder fine boring machine and a honing machine, have been made up from scrap and surplus materials and equipment. The principal items made are :—

Special engine repair trucks	Fig. 4
Special wagons and frames for engine transport	Fig. 6
Engine part cleaning boshes	Fig. 5
Test beds, dynamometers, fuel-weighing machines, &c.	Fig. 7
Gantries, cranes, jibs, and lifting tackle, see	Fig. 3

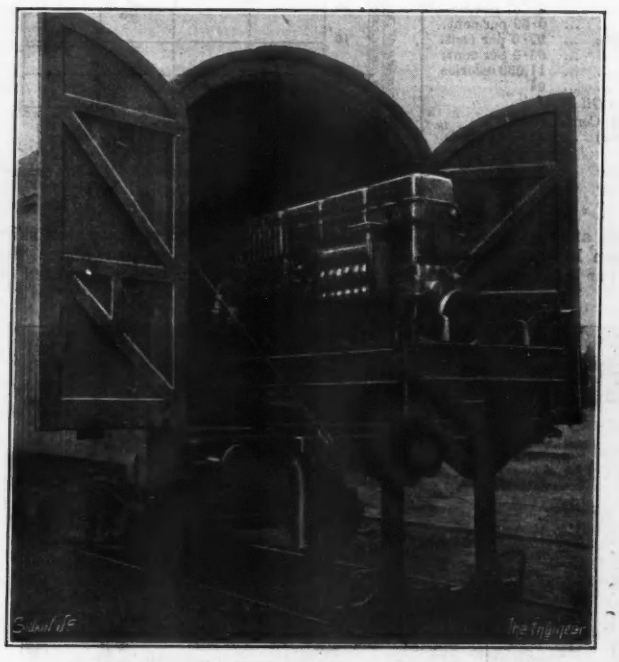


FIG. 6—*Special Wagons and Frames for Engine Transport*

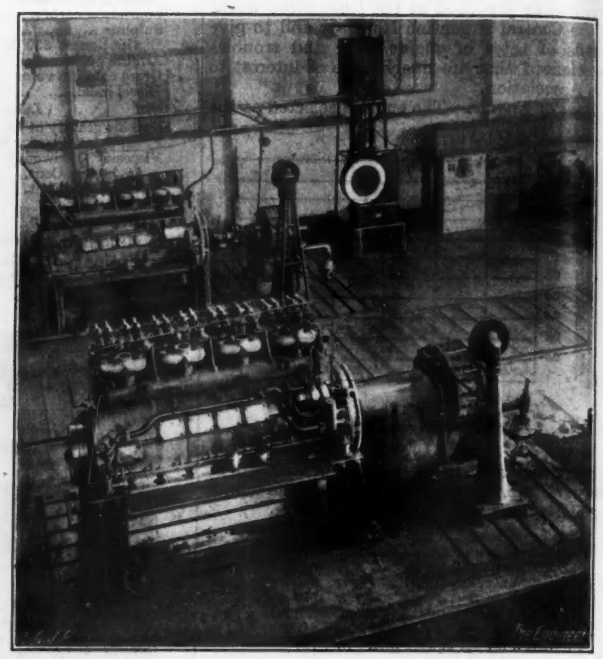


FIG. 7—*Test Beds, Dynamometers, Fuel-weighing Machines, &c.*

TABLE II.—*Crank Pin Diameters*

Total kilometrage of crankshaft, 400,000. Dimensions in millimetres.

As Received from Service

Cylinder No.... ...	1	2	3	4	5	6	7	8
A	107·92	107·90	107·90	107·91	107·91	107·91	107·89	107·92
B	107·92	107·90	107·90	107·91	107·91	107·91	107·90	107·92
C	107·92	107·92	107·91	107·91	107·91	107·91	107·90	107·92
D	107·92	107·92	107·91	107·91	107·91	107·91	107·90	107·92

As Hand Finished

Cylinder No.... ...	1	2	3	4	5	6	7	8
A	107·91	107·89	107·90	107·90	107·90	107·90	107·88	107·91
B	107·91	107·89	107·90	107·90	107·90	107·90	107·88	107·91
C	107·91	107·89	107·90	107·90	107·90	107·90	107·88	107·91
D	107·91	107·89	107·90	107·90	107·90	107·90	107·88	107·91

Original diameter, 108 mm., neglecting maker's error.

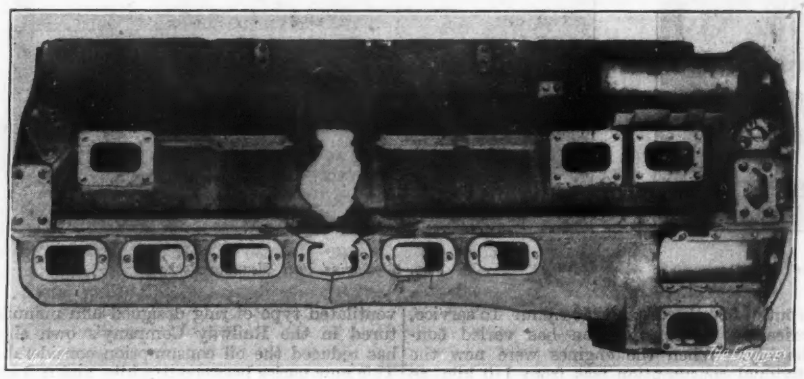


FIG. 8—*Crank Case Damaged due to Breakage of No. 4 Connecting-rod*

In addition, jigs, tools, and other equipment to facilitate overhauls have also been prepared, and those likely to be of interest will be described when dealing with the methods of repair of the different engine details.

Welding.—Existing electric welding facilities and the skilled welders available have played an important part in keeping the engines in service, particularly by the satisfactory repair of light alloy crank cases, &c. Typical examples of crank cases which have been satisfactorily repaired by welding are shown in Figs. 8, 9, and 10.

A broken crankshaft has also been welded, but this work was given to an outside firm of specialists prepared to guarantee results. The welded shaft has not yet been put into service.

Crankshafts.—Crank pins are trued up by hand at each general overhaul, by filing and lapping. This has proved very satisfactory, with the minimum wastage of service metal. Table II shows the dimensions of a set of crank pins after completing 400,000 kiloms., both as received for second general overhaul and after hand finishing. This has been selected as a typical case and is a fair average for all shafts in service, with the exception of those which have suffered scoring due to bearing trouble. Neglecting makers' tolerances, the average rate of crank pin wear, including metal removed in shops, amounts to approximately 0·025 mm. per 100,000 kiloms. Main journals were ground on an existing plain grinding machine at the second general overhaul. This was carried out to rectify original alignment error, as a precaution against crankshaft failures. The journals were reduced approximately 0·5 mm. in diameter. It is anticipated that further grinding will not be necessary until the journals have run well over a million kilometres.

Two crankshaft failures have been experienced. Figs. 11 and 12 show close-up views of the fractures, which in both cases commenced at the radii of No. 8 crankpins. These failures are believed to be due to fatigue, caused by bad alignment of the main bearings, coupled with reduced effectiveness of the crankshaft vibration damper, and aggravated by the rigid nature of the mechanical transmission. It is necessary to mention here that these failures occurred during the period when the partial overhauls were done under contract by the engine manufacturers' staff at the running sheds. Neither the crankshafts nor the main bearings received attention from one general overhaul to the next. The general overhauls were carried out by the railway company at the main repair shops.

It has been found in practice that the main bearing housings, which are of the inverted type, work loose quickly and bed into the light alloy seatings in the crank case. Similarly, the main bearing studs loosen where screwed into the light alloy. In the two cases of the engines with the broken crankshafts, the alignments with the bearings properly tightened up, but with the shafts removed, were found to be as shown in diagrams Figs. 13 and 14. The vibration dampers were found to slip with torques of 235 and 332 kilos.-metres respectively, instead of 143 kilos.-metres, as prescribed by the builders. The adjustment of clearances and the proper tightening up of the bearings at each partial overhaul prevents slackening, good alignment being maintained when they are so treated. The alignment is checked by web flexure readings, with the shaft and bearings free from oil.

Trouble is now being experienced at the conical ends of the crankshafts due to "fretting corrosion." It will soon be necessary to remachine these and build up the corresponding seats in the vibration dampers and fly-wheels by welding. To facilitate overhauls a crankshaft complete with fly-wheel, vibration damper, and connecting-rods is kept in shops as a floating spare. This avoids delay in the repair programme due to a shaft falling behind schedule. The arrangement has proved completely satis-

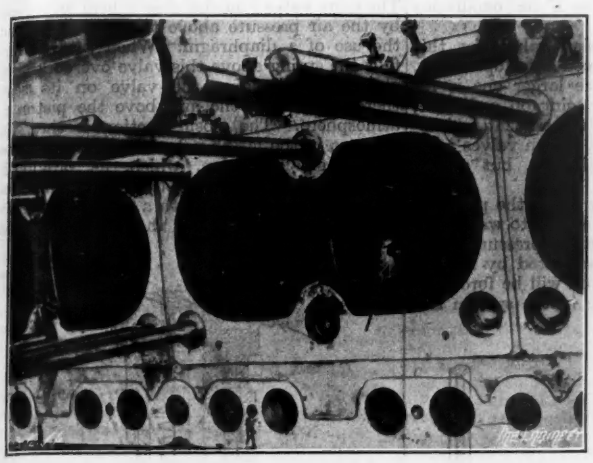


FIG. 9—*Defective Oil Feed Connection Boss in Crank Case*

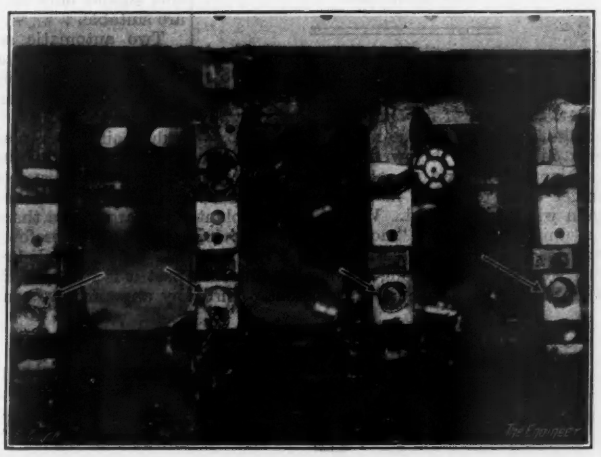


FIG. 10—*Main Bearing Spigot Holes Badly Machined during Manufacture*

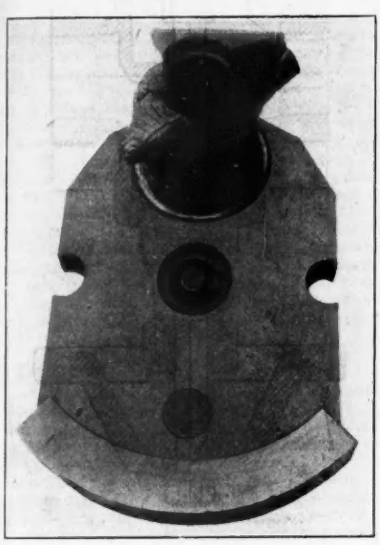


FIG. 11—*Close-up of Fracture of Crankshaft*

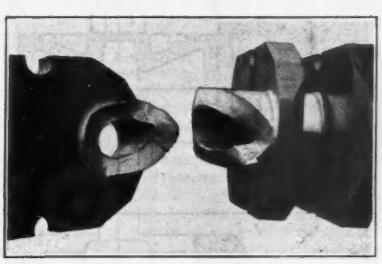


FIG. 12—*Close-up of Fracture of Crankshaft*

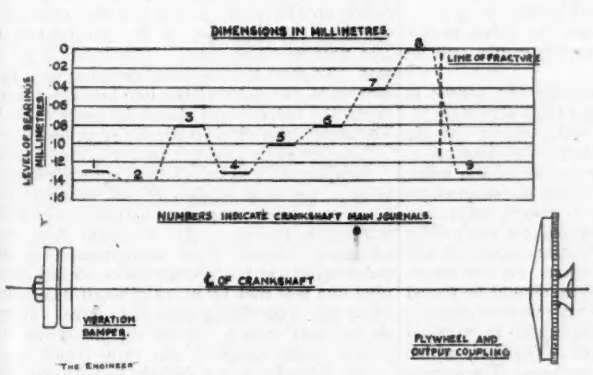


FIG. 13—*Diagram showing Comparative Heights of Loaded Halves of Main Bearings. Zero taken at Highest Bearing*

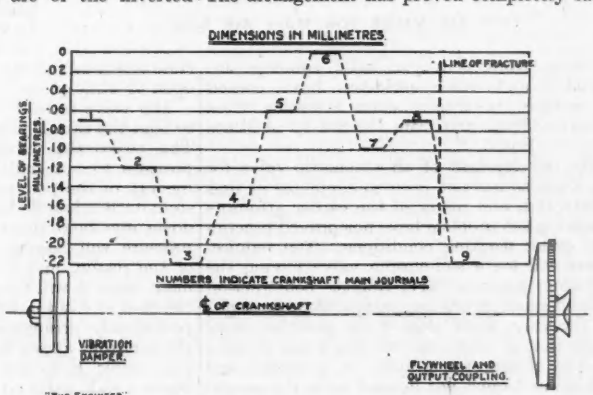


FIG. 14—*Diagram showing Comparative Heights of Loaded Halves of Main Bearings. Zero taken at Highest Bearing*

factory. To enable any scored main or crank pin journals to be machined an old centre lathe has been overhauled and suitably modified.

A magnetic crack-detecting machine has been made on which all shafts are tested. Up to the time of writing no cracks have been found.

(To be continued)

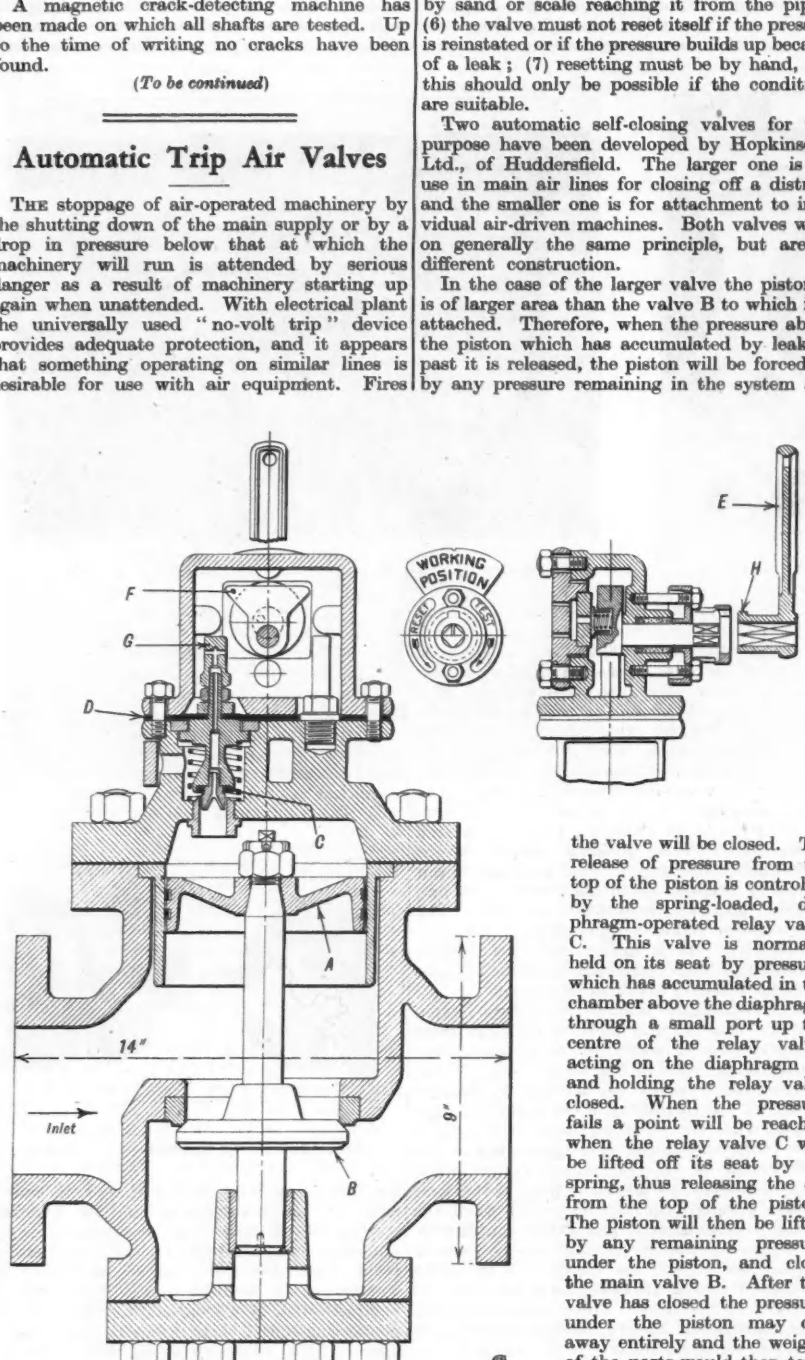
Automatic Trip Air Valves

THE stoppage of air-operated machinery by the shutting down of the main supply or by a drop in pressure below that at which the machinery will run is attended by serious danger as a result of machinery starting up again when unattended. With electrical plant the universally used "no-volt trip" device provides adequate protection, and it appears that something operating on similar lines is desirable for use with air equipment. Fires resulting from conveyor belts running unattended and other accidents have caused the subject to receive close attention from colliery officials and from the Safety in Mines Research Board.

The development of an automatic valve for this purpose has not been so simple as at first anticipated, and many of the earlier attempts at solving the problem have not proved practicable under working conditions. The requirements call for a self-closing valve having the following features:—(1) Robust construction without small protruding parts liable to damage; (2) the valve must close if the pressure drops below that at which the machines can be run; (3) the closing force must be powerful and definite and must not depend upon the weight of the parts or stored up energy of springs; (4) the valve must not waste air by constant leakage past a piston or other control parts; (5) the working parts must have ample clearance so that the valve will not become inoperative by sand or scale reaching it from the pipes; (6) the valve must not reset itself if the pressure is reinstated or if the pressure builds up because of a leak; (7) resetting must be by hand, and this should only be possible if the conditions are suitable.

Two automatic self-closing valves for this purpose have been developed by Hopkinsons, Ltd., of Huddersfield. The larger one is for use in main air lines for closing off a district, and the smaller one is for attachment to individual air-driven machines. Both valves work on generally the same principle, but are of different construction.

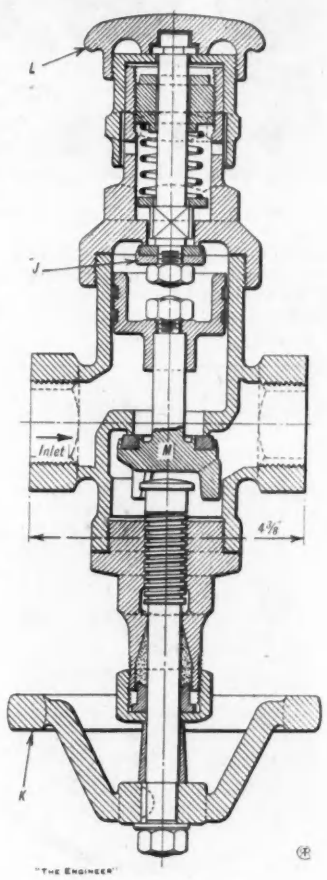
In the case of the larger valve the piston A is of larger area than the valve B to which it is attached. Therefore, when the pressure above the piston which has accumulated by leakage past it is released, the piston will be forced up by any pressure remaining in the system and the valve will be closed. The release of pressure from the top of the piston is controlled by the spring-loaded, diaphragm-operated relay valve C. This valve is normally held on its seat by pressure, which has accumulated in the chamber above the diaphragm through a small port up the centre of the relay valve, acting on the diaphragm D and holding the relay valve closed. When the pressure fails a point will be reached when the relay valve C will be lifted off its seat by its spring, thus releasing the air from the top of the piston. The piston will then be lifted by any remaining pressure under the piston, and close the main valve B. After the valve has closed the pressure under the piston may die away entirely and the weight of the parts would then tend to open the valve. This is quite immaterial, as immediately any pressure is put on the system the valve would close again as the relay valve C would still be open to atmosphere.



TRIP AIR VALVE FOR MAIN AIR LINE

The valve is reset by turning the handle E so that the cam F presses on the valve stem G. This closes the valve C and permits the air pressure to accumulate above the diaphragm by way of the port up the centre of the valve stem until it is sufficient to press the diaphragm down and hold the valve C closed, when the pressure will become equalised on both sides of the piston, and the pressure acting on the main valve A will force it open. As it is essential that any automatic device should be tested periodically, arrangements are made to exhaust the air from above the diaphragm by turning the handle E to the "test" position, which opens a slide valve to atmosphere. This action releases the pressure on the diaphragm, when the piston valve will open and operate the main valve. The operating handle E is provided with a small key H, which is such that the handle can only be removed from its spindle when the valve is left in a working condition.

The smaller valve, illustrated in the second engraving, although working on generally the same principle, is of different construction. The relay valve J in this case is held on its seat by the air pressure above the piston, without the use of a diaphragm. When the pressure falls the spring above this valve overcomes the air pressure holding the valve on its seat, thereby releasing the air above the piston to atmosphere. The closing action is then the same as in the larger valve. A special feature of the smaller valve, which, as previously mentioned, is for use directly on the machines, is that it is combined with a control valve for regulating the speed of the machine. This control valve K, once set, is not interfered with, the starting and stopping of the machine being done by operating the knob L. The lifting of this knob closes the relay valve J. The pressure builds up above the piston and the main valve opens to the limit set by the hand wheel K. The pressure also retains the valve J on its seat. To stop the machine, pressure or a light blow with the palm of the hand on the knob L opens the valve J and closes the main valve M. The automatic closing when the pressure falls follows the same principle as in the larger valve.



TRIP AIR VALVE FOR INDIVIDUAL MACHINE

Samples of these valves have, we are informed, been in use at a number of collieries for some time, and have been demonstrated to various interested parties. All criticism has been adequately met. One with regard to the vulnerability of the sliding piston to dirt in the pipe line was met by putting handfuls of silver sand and iron filings into the valve. It was shown that with a free-fitting piston and the ample power available the only result was a scored cylinder and a slightly leaky valve face, which did not interfere with the subsequent operation of the valve.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer

Economy in the Use of Tin

The overrunning by the Japanese of the principal sources of tin supply in the Far East has entailed upon the United Nations the necessity for great economy in the use of the metal. Efforts in this direction have been carried out in every industry which uses the metal in one form or another. Some of these efforts have been attended with considerable success, and the Canadian Pacific Railway, which is a large consumer, has reduced its consumption by about 60 per cent., and it is stated that this proportion may be increased within a comparatively short time. The largest saving in the use of tin by the C.P.R. has been effected in Babbitts for bearings. By employing arsenical Babbitt the tin content has been cut from a minimum of 6·50 per cent. to a minimum of 1·50 per cent. A large amount of Babbitt used for piston-rod packing, containing as high as 88·50 per cent. tin, has been replaced entirely by a copper-lead composition. Experiments are now being conducted with a 2·50 per cent. silver and 97·50 per cent. lead Babbitt, and preliminary tests indicate favourable results. Solder is another material in which formerly large quantities of tin were consumed. A 50–50 mixture of tin and lead was commonly employed for this purpose in general work, but this ratio has been reduced to 38 per cent. tin and 62 per cent. lead. For some purposes the tin content in solder has been reduced to 25 per cent. tin and 75 per cent. lead, and for tinning Babbitt linings the tin content is as low as 10 per cent., where 50 per cent. solder was previously used. In some cases solder for electrical work contains as high as 95 per cent. tin, but the Canadian Pacific Railway now employs a 2·50 per cent. silver and 97·50 per cent. lead mixture. New locomotive bells are now being made without tin, although previously 16 to 19 per cent. of tin was used in bell metal. A substitute for tin was found in silicon bronze, and although lacking slightly the full resonance of the old bells, the new ones, it is considered, will be satisfactory for the duration of the war. It is expected that copper will also be saved in connection with engine bells. New bells, however, are seldom needed by the C.P.R., as it has been the custom for many years to save the bells from old engines. In the past ten years the railway has required no more than thirty-five new bells for maintenance and new locomotives. The tinning of meat hooks in refrigerator cars and cooking utensils throughout the system consumed large quantities of tin, and in this direction consumption has been halved by careful inspection before retinning, but no satisfactory substitute for tin has been found for this purpose.

The Pig Iron Market

The pig iron situation in Great Britain is, on the whole, satisfactory. Supplies are sufficient to meet the requirements of consumers, although it has long been recognised that they cannot pick and choose the particular brands they would like. The situation has not materially altered, and although the demand for some kinds of pig iron is showing signs of decreasing, it is only to a degree that might be anticipated at a period when the majority of users have covered their requirements to the end of the last quarter of the year. Some improvement has been noticeable in the position of the light castings industry recently, but this has not been on a sufficient scale to give full employment to the industry, and most of the light castings makers are in a position to receive far more work than they have in hand. On the North-East Coast the production of foundry iron is small and most of the producing plants are engaged in making basic pig iron for the steel works. The foundries on the North-East Coast are receiving good supplies, however, from the Midland furnaces. There is an important demand for engineering castings, and most of the producers are using the better-class irons and there is a strong demand for refined iron for this purpose. So much business has passed recently in this description that it is not easy to find a maker prepared to accept new commitments for delivery before the end of the year. The electrical engineering and machine tool industries are well employed and they are absorbing steadily good quantities of Midland foundry iron. On the other hand, the demand from the textile machinery makers is rather patchy, and the quantities of pig iron passing into consumption in this direction are below normal. There is an active demand for hematite and low-phosphoric pig irons, which is in excess of the quantities which consumers are permitted to acquire, licences for these descriptions being issued sparingly. The position of the pig iron industry so far as raw materials are concerned is not unfavourable. Regular deliveries of coke are being received, although the ovens are kept fully employed.

The Midlands and South Wales

The Midland steel works are fully employed and the tempo of operations is gradually increasing to meet the expanding demand for steel of all descriptions for the war industries. Plate makers are inundated with business and, in spite of their best efforts, delivery dates are becoming gradually extended. The demand comes principally from the shipyards, but good quantities are also being taken up by the tank makers and locomotive builders. The armour plate manufacturers are also experiencing a heavy demand, and important tonnages are passing into consumption. Whilst the demand for plates is the most noticeable feature of the finished steel position, the call for alloy steels is providing the industry with delivery problems. The production of this steel has been many times increased, but the demand has also grown and for the time being the call seems to be somewhat in excess of supplies. By careful distribution, however, and by cutting down the use of this steel for any but essential purposes, the Control has avoided delay in deliveries to establishments engaged upon war work. The expectations are that the country's requirements are likely to expand as war production increases. There is also an active demand for steel bars. The engineering industry is absorbing big tonnages of the larger diameters, whilst the re-rolling industry is meeting with a strong request for the smaller diameters. The South Wales iron and steel works are fully employed and there is not likely to be any decline in activity during the current delivery period. Consumers are finding it difficult to place orders for delivery before the end of the year. The steel works have important orders in hand for billets and sheet bars and the production of these descriptions is on a heavy scale. The current production is quickly absorbed and the home output has to be supplemented by deliveries of imported material. The tinplate market remains quiet, although recently the volume of home business has shown some improvement. The increase in the demand for tinplate substitutes has not been maintained. The sheet market has been active and most of the works have order books which will keep them well employed for a long time.

Scotland and the North

Great activity rules in all the Scottish iron and steel works. The demand is intense from munition makers, and there is an incessant and strong request for shell bars. The outstanding feature of the trade remains the heavy demand for plates. The call is principally for ship plates, but locomotive and tank makers are also taking up large quantities and the demand for armour plate is on a considerable scale. A heavy volume of business is passing in steel bars, the heavy sizes being in particularly strong request. Consumers' requirements of alloy steel are unabated and large quantities are passing into consumption by the aircraft makers and armaments industry. Steady activity prevails at the works producing structural steel and constructional engineers are calling for increased quantities of light plates and sections. The sheet industry is not only well supplied with orders, but the demand seems to be increasing, particularly for thin plates. Considerable quantities of sheets are now being consumed in the building of huts for military purposes. The demand for light sections for similar purposes is also on a heavy scale, whilst there is a steady call for reinforcing rods. The re-rolling works are busily employed and have good stocks of billets. In the Lancashire market the demand for special steel is unabated. Specifications are reaching the works in a steady stream and the quantities passing into consumption are considerable. The call for structural steel is maintained and consumers' requirements of small bars are on a heavy scale. The engineering industry is taking up good supplies of the larger diameters. The steel works on the North-West Coast are fully employed and have a considerable tonnage of orders in hand. Generally speaking, the raw materials position is comfortable.

The North-East Coast and Yorkshire

The demand for steel for war purposes, which has been particularly heavy during the present quarter of the year, shows a tendency further to increase, and intensified efforts are being made to expand production. Except in one or two branches the steel makers have been able to maintain their deliveries within reasonable limits, and it is only in a few departments that delivery dates show an inclination to lengthen. Alloy steels, which are being used in increasing quantities by the armaments, aircraft, and munitions makers, are still the most prominent feature of the situation, and although the production is higher than ever before, it still falls short of the demand. For this reason great care is exercised in the distribution of this steel, and the Control impresses upon authorities the need for economy in its use. The rolling mills are fully employed and have sufficient orders in hand to keep them busy for a long time. Big outputs are being obtained and the production of open-hearth steel ingots and semis is scarcely sufficient to meet the pressing demand. No important change has taken place in the plate position. The demand from the large consuming industries, including shipyards, tank makers, and locomotive builders, is unrelaxed, and in this department delivery dates show a tendency to increase, in spite of the steps which have been taken to limit this movement. The heavy production of bars, both large and small, has been maintained and is sufficient to meet the requirements of consumers, whilst the volume of business in structural steel is keeping the producing works fully employed. There is also an active business passing in rails and colliery equipment. Iron and steel works in the Yorkshire district are experiencing an insistent pressure in practically every department. Supplies of semis, however, appear to be ample and imports are still arriving and helping to ease the situation. The manufacturers of armour plate are fully engaged, and there is a heavy request for ship, tank, and boiler plates. The recent revival in activity in structural steel has continued, whilst a considerable tonnage of sheets is passing into consumption. Most of the mills are busy, the demand being principally for the medium and light thicknesses.

Copper, Tin, Lead, and Spelter

The situation in the British non-ferrous metal trades is not unsatisfactory, since, although the Control exercises great care in the distribution of metals, the firms employed upon war work appear to be getting their supplies with regularity and in adequate quantities, and, furthermore, without undue delay. It may not be easy to obtain a licence, since there is an enormous consumption of base metals proceeding, and supplies have to run the risk of lengthy sea routes. It is believed, however, that the operations now proceeding in North Africa will eventually ease the position by enabling the shorter route from Australia and the East to be used. At the same time it is thought that the huge concentration of shipping required to transport the Forces engaged must have reduced the shipping available for the transport of metals. Against this, however, it is believed that the Non-ferrous Metal Control, by its policy of husbanding supplies, will probably have accumulated sufficient stocks to enable the consuming industries to be supplied until the shipping can be again devoted to the task of maintaining supplies to this country, although for a time the arrivals may be smaller. There has been no decline in the consumption of copper, and huge quantities are being used for purposes arising from the war. Little, however, is available for any other purpose. A shortage of labour is reported from the United States and certain other producing countries. No doubt steps will be taken to remedy the position. The pooling arrangements by which supplies for the United Nations are allocated by a central committee appear to be working satisfactorily, although the requirements must throw a strain upon the resources of the producing countries. . . . The situation in the tin market has not changed for some weeks, and is principally concerned with finding methods of economising in the use of the metal and increasing the production of those countries under the control of the Allied Nations. In the United States efforts are being made to increase the recovery of secondary tin, and, according to the official figures, in 1941 37,529 tons were obtained, an increase of 26·5 per cent. over 1940. . . . Generally, the lead position is satisfactory, and the essential requirements of the war industries in Great Britain are fully met. Consumption is on an increasingly heavy scale, and there is an expanding use of secondary metal. Supplies continue to reach this country with regularity, and it is understood that the Non-ferrous Metal Control has accumulated a good reserve against eventualities. . . . Tight conditions continue to rule in the spelter market. The drastic steps which have been taken to reduce the use of spelter for unessential purposes appear to have met with some measure of success, but the position remains tight. In the United States somewhat easier conditions exist than in the earlier part of the year as a result of fresh productive capacity coming into operation.

Notes and Memoranda

Rail and Road

NEW PRIVATE CARS.—The manufacture of private cars has ceased, except for those under construction, licences to acquire which have already been issued. The Ministry of War Transport cannot therefore accept any further applications for licences to acquire new private cars for civilian purposes.

THE TRANS-SAHARAN RAILWAY.—This enterprise' otherwise known as the Mediterranean-Niger route' was held up in midsummer, but the work of construction has now been resumed. When work was suspended in July it had reached a point about 40 miles south of Colomb Bechar, in Algeria. Beni Abbas, approximately 225 miles from Colomb Bechar, is stated to be the objective by the beginning of 1943.

RAILWAY WATCHES.—What are known in the U.S.A. as "railroad standard watches," are popular with some sections of the public. As from a recent date, they are to be sold by the manufacturers only to fill orders for the Army or for time-service employees of railways. Under this new W.P.B. order, a watch manufacturer may sell or deliver "railroad standard watches" only as follows:—(1) To fill orders for the Army; (2) to fill an order accompanied by a certificate signed by a railway time-service employee and his division superintendent, stating that the railway for which he works requires him to carry a "railroad standard watch," and that he has no such watch.

OILING OF FISH-PLATES.—The oiling of fish-plates is exercising the minds of American railway engineers. With the standard 39ft. American rails, it has been found that it cost about 4 dollars per mile to do the work and that it may be worth while to do it. The argument is that by periodically applying oil to the working surfaces of fish-plates a certain freedom of movement between the two adjacent rail ends and the plates is assured to allow the necessary movement of the rails that arises by expansion or contraction with changes of temperature. The practice ensures advantages derivable from regular attention to fish-plate oiling; tends to keep the fish bolts in good condition by sealing the thread against the seepage of water to the bolt, and so facilitates adjustment at any time.

DISTRIBUTION OF WORK CREATES FRESH TRAFFIC PROBLEMS.—The subdivision of work in the U.S.A. to speed up production has entailed the transport of large and often heavy units from production shop to assembling yard. The General Electric Company of America has recently taken delivery of eight bogies of the well type from the shops of the Boston and Main Railway Company. They have been designed to facilitate the shipment of gears up to 15ft. in diameter for marine propulsion sets. A feature is a steel superstructure easily adjustable lengthwise at 2½in. intervals to accommodate gears of various dimensions. The superstructure is included in the tare weight of the car, and eliminates about 15,000 lb. of steel required for skids and fastenings in the shipping method previously used. Despite this saving, a complete car weighs about 29 tons.

THE COST OF RUNNING LOCOMOTIVES.—Speaking recently before the Railway Club of Pittsburgh, Professor Louis E. Endsley gave some comparative figures on the cost of running oil and steam locomotives. He gave it as his opinion that the oil-electric locomotive could be run at higher speeds than could any form of steam locomotive of the reciprocating type because of the counterbalance blow on the rail at high speeds, and, speaking from the point of view of practice and experience in the U.S.A., he cited the lower fuel bills of the oil-engined locomotive. Comparative figures showed the cost of 600 H.P. and 900 H.P. oil-electric shunting locomotives and corresponding steam-engined units. The former used an average of 5·6 gallons of fuel oil per hour, and the 900 H.P. 6·4 gallons. At a cost of 5c. per gallon for fuel oil the fuel cost for each oil locomotive was between 28c. and 35c. per hour. Corresponding steam locomotives averaged between 600 lb. and 1200 lb. of coal an hour, so that, even taking the price of coal at only 2 dollars a ton, it was evident that the oil locomotive fuel cost was much lower.

Miscellanea

A NEW USE FOR PEAT MOSS.—Canadian and U.S.A. makers of magnesium are increasingly using peat moss as a refining agent in the manufacture of magnesium. One of the principal producers of the metal at Las Vegas, Nevada, will require from 700,000 to 1,000,000 bales of sphagnum peat moss per year. The quantity and quality of the peat moss required are not obtainable in the United States, but the British Columbia output meets requirements and, if production could be increased, adequate supplies would be available from that State.

THE LATE MONSIEUR EUGENE SCHNEIDER.—It is reported from France that Monsieur Eugene Schneider, the head of Schneider et Cie, proprietors of the famous armament works at Le Creusot, which were recently bombed by the Royal Air Force, died at his home in Paris on Tuesday morning, November 17th. Monsieur Eugene Schneider was a metallurgist and industrialist of outstanding merif, and we hope to refer to his career in a later article.

THE SUPPLY OF CORK.—So short is the supply of cork in the U.S.A., due to the shutting off of many European imports, that efforts are being made to produce a home-grown cork. Reports from the University of Washington indicate that experiments have developed a method for removing cork from the Douglas fir where it lies in a series of flakes just inside the outer bark. While not equal to the Mediterranean cork oak, it is claimed that the substitute will serve many useful purposes.

PICTURES FOR CANTEENS.—The National Gallery has published four lithographs in colour for the decoration of factory canteens. They are reproductions of pictures in the War Artists' Exhibition by Stanley Spencer, Paul Nash, Barnett Freedman, and Edward Ardizzone, and each measures 40in. by 30in. Four additional prints of war pictures, slightly smaller in size, are also available, as well as three landscape subjects. The prices of these reproductions range from 9d. to 4s. each. Orders should be sent to the Supervisor of Publications, The National Gallery, London, W.C.2.

MACHINERY, PLANT, AND APPLIANCES (CONTROL) ORDERS.—In order to correct any misunderstanding as to the necessity for licences for repair parts, the Board of Trade has drawn the attention of all users of machinery, plant, and appliances controlled by the Orders to the fact that repair parts can only be supplied without licence if they are required for the immediate and essential repair of machinery, &c., which is in current use. If an owner wishes to acquire parts for machinery which, because of concentration or for other purposes, is not in current use, he must obtain a licence before accepting the parts. Failure to do so is an offence under the Orders.

Personal and Business

THE MINISTER OF WAR TRANSPORT has appointed Mr. Tom Macpherson to be Regional Port Director for Scotland, in the place of Mr. Robert Letch, who has been transferred to the North-Western Region.

THE LATE MR. RAYMOND LEA.—We greatly regret to have to record the death of Mr. Raymond Lea, the replacement manager of Specialloid, Ltd. (acting Piston Controller for the Ministry of Supply). Mr. Lea was killed as the result of an accident in London, during which he gave his life to save another.

THE INTERNATIONAL HARVESTER COMPANY OF GREAT BRITAIN, Ltd., and RUSTON-BUCYRUS, Ltd., announce that Saville (Tractors), Ltd., 2061, Coventry Road, Sheldon, Birmingham, 26, has been appointed distributor for sales and service in Wales, Northern Ireland, Shropshire, Staffordshire, Warwickshire, Worcestershire, Herefordshire, and Monmouthshire; and that J. C. Oliver, Ltd., 45, Burton Street, London, W.C.1, has been appointed distributor for sales and service for that part of England, excluding Monmouthshire, south of the southern boundaries of Herefordshire, Worcestershire, Warwickshire, Leicestershire, Rutlandshire, and Lincolnshire.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, Nov. 23rd.—Technical College, Bradford. "The Diesel Engine," J. G. Jagger. 6.45 p.m.

Institute of Fuel

Thursday, Nov. 26th.—Connaught Rooms, Great Queen Street, W.C.2. "The Standardisation of the Critical Air Blast Test," D. H. Bangham and G. C. Philpotts. 2.30 p.m.

Institute of Transport

Saturday, Nov. 21st.—METROPOLITAN GRADUATES: Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Public Co-operation in Transport," J. E. Cowderoy. 2.15 p.m.

Tuesday, Nov. 24th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Town and Country Planning and Transport Problems," G. Mills. 1.15 p.m.

Tuesday, Dec. 1st.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon and address by W. L. Runciman. 12.45 for 1.15 p.m.

Institute of Welding

Wednesday, Dec. 2nd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Presidential Address, R. Freeman. "Brief Review of Electric Welding as Applied to Shipbuilding in the United Kingdom," Sir Amos Ayre. 6 p.m.

Institution of Civil Engineers

Tuesday, Nov. 24th.—ROAD ENGINEERING DIVISION: Great George Street, Westminster, S.W.1. "The Construction of Bases for Roads and Aerodromes Using Local Aggregates and Soils," A. H. D. Markwick and H. S. Keep. 5.30 p.m.

Tuesday, Dec. 1st.—Great George Street, Westminster, S.W.1. "Hydro-electric Development: Some Economic Aspects," J. K. Hunter and R. W. Mountain. 2 p.m.

Institution of Electrical Engineers

To-day, Nov. 20th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "A Differential Electronic Stabiliser for Alternating Voltages and Some Applications," A. Glynne. 5.30 p.m.

Saturday, Nov. 21st.—N. MIDLAND CENTRE: Great Northern Hotel, Leeds. "A High-voltage High-rupturing Capacity Cartridge Fuse and its effect on Protection Technique," K. Dannenberg and W. J. John. 2.30 p.m.

Monday, Nov. 23rd.—Informal meeting. Savoy Place, Victoria Embankment, W.C.2. Discussion, "The Electronic Control of Industrial and Power Plants." 5.30 p.m.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Some Factors Affecting the Design of Alternators for Switchgear Testing," V. Easton. 6.15 p.m.

Institution of Mechanical Engineers

To-day, Nov. 20th.—Storey's Gate, Westminster, S.W.1. "Caustic Embrittlement," E. W. Colbeck, S. H. Smith, and L. Powell; "Corrosion of Boiler Tubes," T. Henry Turner. 5.30 p.m.

Saturday, Nov. 21st.—SOUTHERN BRANCH: Kimbell's Café, Osborne Road, Southsea. "Recent Developments in Refrigeration," Lord Dudley Gordon. 2 p.m.—YORKSHIRE GRADUATES: Technical College, Huddersfield. Discussion meeting. 2.30 p.m.

Saturday, Nov. 28th.—YORKS BRANCH: Chemistry Lecture Theatre, The University, Leeds. Recent Developments in Refrigeration," Lord Dudley Gordon, 2.45 p.m.—LONDON GRADUATES: Storey's Gate, Westminster, S.W.1. "Erection of a 30,000-kW Turbo-alternator," J. G. Dobinson. 3.30 p.m.—MANCHESTER GRADUATES: Engineers' Club, Albert Square, Manchester. "Critical Speeds of Torsional Vibration," H. S. Marmorek. 2.30 p.m.

Institution of Production Engineers

Saturday, Nov. 21st.—LONDON SECTION: Inst. of Civil Engineers, Great George Street, S.W.1. Discussion, "Problems of Shift Working in a General Engineering Factory." 2.30 p.m.

Friday, Nov. 27th.—EASTERN COUNTIES SECTION: The Museum, High Street, Ipswich. "Production Control," Mr. Appleby. 7 p.m.—N.E. SECTION: County Hotel, Newcastle-upon-Tyne. Discussion, "Care and Maintenance in a Machine Shop." 6.15 p.m.

Saturday, Nov. 28th.—NOTTINGHAM SECTION: Victoria Station Hotel, Nottingham. Presidential Address, Sir Ernest Lemon. 2.45 to 3 p.m.

Junior Institution of Engineers

To-day, Nov. 20th. — 39, Victoria Street, S.W.1. "Appointments Department Within the Ministry of Labour and National Service," E. W. Hoyle and A. C. R. Ritchie. 6 p.m.

Friday, Nov. 27th.—39, Victoria Street, S.W.1. "Purchasing and the Purchasing Agent," N. L. Ablett. 6 p.m.

Keighley Association of Engineers

To-day, Nov. 20th.—Victoria Hotel, Keighley. "The Substitution of High-duty Grey Iron for Steel Castings," J. Blakiston. 7.30 p.m.

Manchester Association of Engineers

Saturday, Nov. 21st.—Engineers' Club, Albert Square, Manchester. "Exhaust Pipe Phenomena," G. F. Mucklow. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Nov. 27th.—Mining Institute, Newcastle-upon-Tyne. Andrew Laing Lecture, "The British Merchant Shipbuilding Programme in North America, 1940–42." R. C. Thompson and H. Hunter. 6 p.m.

Royal Society of Arts

Monday, Nov. 23rd.—John Adam Street, Adelphi, W.C.2. "Thermal Insulation at Medium Temperatures," A. C. Pallot. 1.45 p.m.

Wednesday, Dec. 2nd.—John Adam Street, Adelphi, W.C.2. "Machinery in Modern Farming," D. R. Bomford. 1.45 p.m.

Society of Chemical Industry

To-day, Nov. 20th.—MANCHESTER SECTION: Grand Hotel, Aytoun Street, Manchester. "Why is Rubber Elastic?" L. R. G. Treloar. 2 p.m.